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Diagnostic Operational Modeling Programs for Municipal Wastewater Treatment Plants Field Evaluation and Process Review Project Report

ES Environmental Services, Berkeley, CA

Prepared for

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The project described in this report was undertaken in order to provide EPA Region X with easily applied user oriented computer programs based on ES Environmental Services, Inc. (ES_2) methodologies which would rapidly and accurately predict treatment plant performance capabilities and process parameters under a wide variety of operating conditions. The project involved diagnostic computer modeling and on site field evaluation of 15 municipal treatment plants in Region X to verify the accuracy of the programs. In addition, ten treatment plants currently under design in Region X were modeled to determine their ability to meet anticipated discharge requirements. The results of the field validation effort have shown that the predictive methodologies developed by ES_2 are very accurate under normal operating conditions in all types of treatment plants surveyed.

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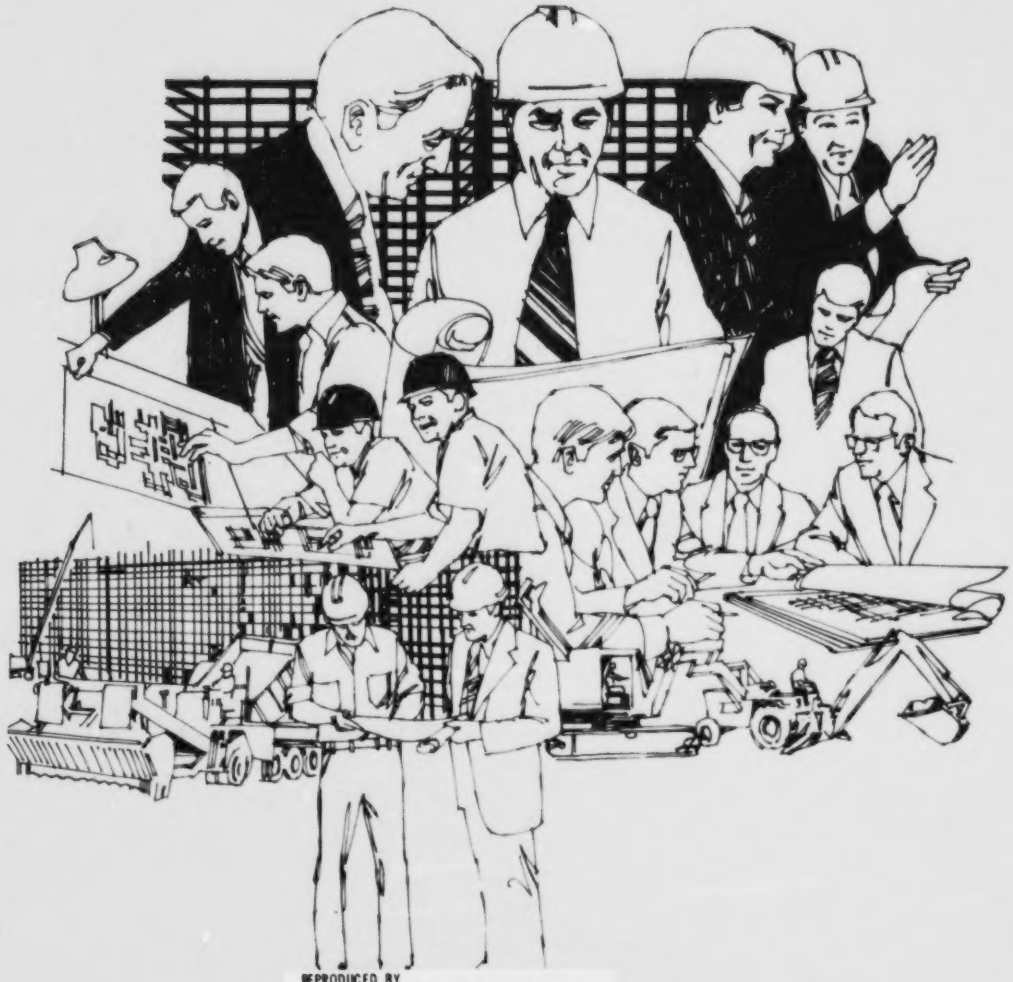

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DIAGNOSTIC OPERATIONAL MODELING PROGRAMS FOR MUNICIPAL WASTEWATER TREATMENT PLANTS FIELD EVALUATION AND PROCESS REVIEW PROJECT REPORT

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CHAPTER 1

INTRODUCTION

Within the last ten years, an enormous amount of progress has been made in improving wastewater treatment throughout the United States. In the early 1970's, the major objective of the EPA and other federal and state agencies was to provide funds for construction of treatment facilities to communities with the greatest needs.

With the completion of many of these new facilities came a growing awareness of the need to effectively evaluate the performance of municipal treatment plants in order to achieve the best and most economical operation. Recent cutbacks in construction grants and increases in energy and chemical costs have heightened this awareness. Many communities are now faced with the need to improve the operation of existing plants and, at the same time, to minimize operating costs.

The evaluation of treatment plant performance, process requirements and process limitations is a traditional part of the work done by operators and engineers in the municipal wastewater field. However, a detailed and complete process evaluation done by traditional methods can be a massive undertaking even when done for only one set of operating conditions. The effort required to fully analyze several alternative operating strategies, each under several different loading conditions, can be prohibitive to a plant staff and very expensive if provided by a consultant. Moreover, the modeling of treatment plant performance under projected conditions involves so many assumptions that the experience and judgement of the person performing the calculations becomes a very significant factor.

Purpose of the Project

ES Environmental Services, Inc. (ES_2) has, for some time, used methods developed by experienced operations engineers to predict significant operating parameters and final effluent quality that could be achieved by several types of municipal wastewater treatment plants under a given set of conditions. These methods are based both on theory and on documented performance of numerous treatment plants throughout the United States.

The project described in this report was undertaken in order to provide EPA Region X with easily applied user oriented computer programs based on ES_2's methodologies which would rapidly and accurately predict treatment plant performance capabilities and process parameters under a wide variety of operating conditions. The project involved diagnostic computer modeling and on site field evaluation of 15 municipal treatment plants in Region X to verify the accuracy of the programs. In addition, ten treatment plants currently under design in Region X were modeled to determine their ability to meet anticipated discharge requirements. The results of the field validation effort have shown that the predictive methodologies developed by ES_2 are very accurate under normal operating conditions in all types of treatment plants surveyed.

Objectives of Diagnostic Evaluation

Diagnostic evaluation of municipal wastewater treatment plants can be of great benefit to those facilities which are operating within their discharge limits, as well as those which are having problems with compliance.

The primary objective of evaluating plants with compliance problems is to identify those factors which are responsible for the poor performance. Generally such difficulties are attributable to one of three major causes:

1. Organic and/or hydraulic overload of the entire plant.
2. Serious limitations in one or more specific unit processes.
3. Improper operation.

Effective diagnostic evaluation methodology allows these determinations to be made quickly and with a high degree of certainty. Prompt and proper identification of the true problem is essential for providing effective assistance to non-compliant facilities.

In cases where plants are overloaded or have serious process limitations, expansion or retrofitting is usually necessary. Results of the diagnostic evaluation can serve as a preliminary basis for planning this work. In cases where compliance problems are due to improper operations, the only effective solution is to provide training programs for the plant staff to improve their understanding of process control strategies and their implementation.

Diagnostic evaluation of municipal treatment plants which are operating well within their discharge limits can also identify existing or potential training needs related to process optimization. It is often possible to lower energy and chemical costs and conserve labor and materials by implementing improved process control strategies and operating procedures.

Program Capabilities

Ten separate Diagnostic Operational Modeling Programs have been prepared as part of this project. These include the following:

1. Primary treatment
2. Conventional activated sludge, with or without primary sedimentation
3. Single stage activated sludge for nitrification, with or without primary sedimentation
4. Extended aeration activated sludge with or without primary sedimentation
5. Extended aeration oxidation ditch with or without primary sedimentation
6. Contact stabilization, with or without primary sedimentation

7. Activated bio-filter, with or without primary sedimentation
8. Single stage trickling filter with primary sedimentation
9. Two stage trickling filter with primary sedimentation
10. Rotating biological contactors with primary sedimentation

Each program allows the option of an anaerobic or aerobic sludge digestion analysis.

The programs have been prepared for use with the Apple II plus minicomputer. Each program is structured to accept data on plant configuration and wastewater characteristics in question-and-answer format to simplify program use. All data on the configuration of a particular plant can be stored on the program disk and recalled later to save time. Each time a program is run, the computer lists all the input data and then establishes a series of 20 flow rates beginning slightly lower than the existing average flow and continuing slightly beyond the plant's design flow. The computer then calculates and prints out all significant operating parameters for each major unit process as well as final effluent quality for each of the 20 selected flow rates. Each run takes roughly 15 minutes and represents an estimated three to four person weeks of effort if done by hand. A program which allows graphical display of the output data is also available.

Program Limitations

The primary reason for preparing the Diagnostic Operational Modeling Programs was to provide a means of identifying the process capabilities of a typical municipal wastewater treatment plant operating under relatively normal conditions. The predictive methodology on which the modeling programs are based is complex and involves a very realistic series of interactions between unit processes. Of course, no analytical technique is perfect. The programs do make certain assumptions which require on-site verification. These assumptions include the following:

1. Wastewater is typical domestic sewage, with no significant industrial component, abnormally high variability or unusually high strength recycle flows.

2. Clarifiers (both primary and secondary) have minimal short circuiting.

3. Clarifiers (both primary and secondary) have adequate sludge collector capacity.

4. Both primary and secondary sludge reaches ultimate compaction in the clarifiers.

5. There is no toxic inhibition of biological processes.

6. There is no oxygen limitation in biological processes.

7. The flow split between parallel process units results in uniform hydraulic and organic loading.

8. Distribution of flow over fixed film biological reactors is uniform.

9. Suspended growth biological reactors are uniformly mixed.

10. All unit processes have adequate pump capacity.

The programs were also written to be most accurate in the normal operating range of municipal treatment plants. The experience gained in field validation of the programs indicates that if the assumptions listed above are met, the effluent BOD and TSS predictions are generally accurate to within 10 or 15 percent in the range between 10 mg/l and 50 mg/l. Other operating parameters computed by the programs are also quite accurate when these conditions are met. Under operating conditions which result in effluent quality significantly better or worse than this range, the accuracy of the modeling programs falls off.

Output Interpretation

The Diagnostic Operational Modeling Programs prepared by ES_2 are not, and were not intended to be, a substitute for sound judgement. The computer simply saves time and money. The output from the programs cannot be interpreted and used in a meaningful way unless the user has a thorough understanding of both treatment processes and of the modeling programs which simulate their performance. With this understanding and with the judgement which comes from experience, the Diagnostic Operational

Modeling Programs have proven to be an extremely valuable tool for evaluating the performance of municipal wastewater treatment plants under various conditions. This can lead to improved effluent quality, rapid identification of process limitations and overload conditions, reduced operating costs and increased process stability.

CHAPTER 2

SUMMARY AND CONCLUSIONS

The accuracy of the Diagnostic Operational Modeling Programs' effluent quality predictions, and the usefulness of these programs in identifying process limitations and operational deficiencies, was demonstrated by conducting diagnostic evaluations at 15 municipal treatment plants in EPA Region X. After these evaluations were completed, the programs were used to screen ten treatment plant designs being prepared in Region X for potential process limitations. This Chapter presents a brief summary of the information gathered during these phases of the project, and the conclusions which were drawn from this information.

In this and all subsequent Chapters, the term "process limitation" will refer to physical aspects of a treatment facility which limit its overall performance. The term "operational deficiency" will refer to limitations imposed by poor process control.

2.1 Diagnostic Evaluation Methodology

The 15 treatment plants evaluated in this project were selected by individuals from EPA Region X, the states of Washington and Idaho, and from Boise State University. Plants were selected to include as many different processes as possible, and ranged in design capacity from 0.2 to 17.0 mgd.

Information request forms were then sent to the superintendents of these plants to obtain data needed to run the Diagnostic Operational Modeling Programs. This information included the dimensions of all major process units, as well as average influent wastewater characteristics and effluent quality for the previous year. The programs were then run

to determine the effluent quality that could be achieved by each plant under ideal conditions. Predicted and actual effluent quality were compared, and differences between predicted and actual values of significant operating parameters were noted.

The second step in the evaluations consisted of an on-site inspection of each plant to assess actual operating conditions, review lab data, identify process limitations and/or operational deficiencies and evaluate alternative operating strategies which would reduce operating costs. These inspections were conducted by one or more operations specialists from ES_2. In some instances, individuals from EPA Region X and the states of Washington and Idaho were also present. Each inspection required one day or less to complete.

After conducting the inspections, recommendations were made to correct operational deficiencies. Those plants which had process limitations were remodelled with specific adjustments made in the programs to prove that the algorithms could accurately simulate plant performance under the conditions that actually existed.

Finally, second visits were made to seven of the treatment plants to assist with implementation of the recommendations made previously, conduct tests which could lead to improved plant performance, and obtain additional data to validate the programs.

The results of the fifteen diagnostic evaluations are summarized in Table 2.1.

2.2 Process Analysis Methodology

The Diagnostic Operational Modeling Programs can be used not only to simulate the performance of existing treatment plants, but also to evaluate the process capabilities of plants under design once all major criteria have been established. This has obvious advantages as a screening measure which can identify potential process limitations which could prevent a plant from meeting anticipated discharge requirements.

TABLE 2.1

SUMMARY OF TREATMENT PLANT DIAGNOSTIC

Treatment Plant Name	Type of Biological Process	Design Flow (mgd)	Actual Flow (mgd)	Process Limitations Identified	Operational Deficiencies Identified	Predicted Effluent Before Calibration (BOD/TSS, mg/l)
Aberdeen, ID.	Extended Aeration (Activated Bio-Filter)	0.60	0.32	None	None	5/12
American Falls, ID.	Single Stage Trickling Filter	0.90	0.37	Inadequate sludge pumping capacity in secondary clarifier	None	20/24
Caldwell, ID.	Two Stage Trickling Filter (Single Stage Trickling Filter)	7.78 (7.78)	3.2 (3.8) (6.5)	None	None	17/17 (32/32)
Centralia, WA.	Single Stage Trickling Filter	4.3	1.48	Uneven flow distribution over trickling filters	Inadequate sampling due to insufficient staffing	7/7
Gig Harbor, WA.	Conventional Activated Sludge	0.45	0.235	Inadequate oxygen transfer capacity. Secondary clarifiers too shallow	None	68/89
Idaho Falls, ID.	Activated Bio-Filter	17	6.8	None	None	5/5
Ketchum, ID.	Extended Aeration	2.25	0.72	Turbulence in one secondary clarifier. Lack of instrumentation and process flexibility	None	5/5
Lander St., ID.	Conventional Activated Sludge	15.0	9.1	Marginal oxygen transfer capacity. Turbulence in primary clarifiers. Inability to measure flow split to secondary clarifiers	Improper sampling location	5/6
Meridian, ID.	Activated Bio-Filter	2.82	2.04	None	None	5/6
Monroe, WA.	Rotating Biological Contactor	1.40	0.50	Rotating Biological Contactors have inadequate capacity. Uneven flow split between RBC trains. Turbulence in secondary clarifiers. Effluent weirs not level.	None	57/60
Pocatello, ID.	Conventional Activated Sludge	12.0	5.98	Marginal oxygen transfer capacity. Secondary clarifier design limits thickness of sludge blanket.	None	5/5
Shelton, WA.	Extended Aeration Oxidation Ditch	7.5	2.5	None	Rag accum. on aerators in aerobic digester, possibly resulting in low DO levels. Insufficient staffing. Insuffient operator training.	5/5
Sultan, WA.	Extended Aeration Oxidation Ditch	0.20	0.065	Poor mixing of return activated sludge and influent wastewater		5/5
Toppenish, WA.	Rotating Biological Contactors	1.35	0.879	None	None	7/8
West Boise, ID.	extended Aeration	5.0	4.42	None	None	5/5

TABLE 2.1

MENT PLANT DIAGNOSTIC EVALUATIONS

al ies ed	Predicted Effluent Qual. Before Calibration (BOD/TSS, mg/l)	Actual Effluent Quality (BOD/TSS, mg/l)	Predicted Effluent Qual. After Calib. (BOD/TSS, mg/l)	Additional Notes
	5/12	7/2	5/7	Biological process followed by effluent filters. This effect was not simulated in computer models.
	20/24	60/45	--	Plant currently under expansion. Secondary sludge pump near failure, and is operated intermittently.
	17/17	25/33	--	Biological process followed by effluent filters. This effect was not simulated in computer models.
	(32/32)	(46/33)	--	
e sampling sufficient	7/7	20/28	--	Uneven flow distribution over trickling filters improved on second plant visit.
	68/89	22/27	24/31	Extremely high diurnal variation in organic loading to plant.
	5/5	6/7	5/6	Organic and hydraulic loadings much lower than design values.
	5/5	10/25	5/5	Alum added for phosphorus removal results in very high MLSS concentration.
sampling	5/6	8/14	7/10	Filamentous growth resulting in high SVI's controlled by chlorination.
	5/6	5/5	5/11	Model particularly sensitive to thickness of sludge blanket and depth of secondary clarifiers in current mode of operation.
	57/60	36/10	--	BOD and TSS removal across influent fine screens not varified.
	5/5	14/9	9/12	None
m. on aerators ic digester, resulting in levels. ient staffing. nt operator .	5/5	2/8	5/7	Present organic loading very low.
	5/5	30/30	5/5	None
	7/8	6/5	--	None
	5/5	2/2	5/5	Present organic loading very low.

TABLE 2.1 (cont.)

SUMMARY OF TREATMENT PLANT DIAGNOS

Treatment Plant Name	Type of Biological Process	Design Flow (mgd)	Actual Flow (mgd)	Process Limitations Identified	Operational Deficiencies Identified	Actual Effluent Quality (BOD/TSS, mg/l)	Predict Qu (BOD/TS
Chamberlain, SD.	Oxidation Ditch	0.41	0.27	Turbulence in secondary clarifier. RAS pumps oversized, inadequate chlorine solution mixing	Poor sludge wasting program. Inadequate operator training	15/28	5/5
Enumclaw, WA.	Rotating Biological Contactor	2.4	1.96	None	None	20/19	21/2
Ft. Knox, KY.	Rotating Biological Contactor	6.0	4.0	None	None	12/14	11/1
Moab, UT.	Single Stage Trickling Filter	1.0	0.76	Inefficient chlorine Mixing	None	29/27	27/2
Mobridge, SD.	Rotating Biological Contactor	0.63	0.40	Hydraulic surges du to "fill and draw" influent pumping	None	29/22	27/2
Pierre, SD.	Rotating Biological Contactor	1.90	1.14	First shaft in each train heavily loaded. Inability to measure flow split to primary clarifiers	Digester start-up inadequate	31/27	20/2
Springville, UT.	Two-stage Trickling Filter	3.5	2.81	None	None	19/23	17/1
Wapato, WA.	Rotating Biological Contactor	1.1	0.61	None	None	16/8	15/1

Note: Plants on this page were not analyzed as part of this project, but are presented as examples from others to indicate model use and relia

TABLE 2.1 (cont.)

TREATMENT PLANT DIAGNOSTIC EVALUATIONS

Actual Effluent Quality (BOD/TSS, mg/l)	Predicted Effluent Quality (BOD/TSS, mg/l)	Additional Notes
15/28	5/5	Sludge blanket overflowed weirs during daily high flows. Otherwise plant performed as predicted.
20/19	21/22	Plant receives significant amount of pickle processing waste most of the year.
12/14	11/11	None
29/27	27/28	Plant originally designed to meet 50/50 limit at design flow.
29/22	27/29	Secondary system near capacity at present flow.
31/27	20/24	Poor digester performance results in heavy supernatant load on plant.
19/23	17/19	None
16/9	15/14	None

o indicate model use and reliability.

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The ten treatment plant designs evaluated in this project were selected by individuals from EPA Region X and the states of Washington and Idaho. Information needed to run the programs was provided by individuals from the states of Washington and Idaho, and was based on process criteria used by the design firm.

The plant configuration and wastewater characteristics were used to predict effluent quality for all ten plants under various loading conditions. The results of this evaluation were presented to EPA Region X, and those plants with potential process limitations were identified. A meeting was subsequently held to discuss those plants with representatives of the design firms who wished to attend. The results of the process analysis are summarized in Table 2.2.

2.3 Conclusions

Eight of the ten Diagnostic Operational Modeling programs were used and validated in this project. The primary treatment and contact stabilization programs were not used. However, the analytical methodology on which these programs are based is similar in many important respects to that used in the programs which were validated, and it is expected that they would produce equally accurate results.

Of the fifteen existing treatment plants evaluated, only one reported a significantly better quality effluent than was predicted by the Diagnostic Operational Modeling Programs. That plant was, however, in violation of its discharge limit as was predicted by the program. In all plants surveyed, use of the modeling programs allowed rapid identification of process limitations, operational deficiencies and alternative operating strategies which could lead to significantly reduced operating costs. Calibration of the programs to simulate the operation of plants with process limitations further demonstrated the accuracy of the program algorithms.

Comparison of actual plant effluent quality with the predictions of the Diagnostic Operational Modeling Programs indicated that the following items should be taken into consideration when gathering data to use

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TABLE 2.2

SUMMARY OF TREATMENT PLANT PROCESS ANALYSES

Treatment Plant Name	Type of Biological Process	Design Flow (mgd)	Anticipated Effluent Quality Requirement (BOD/TSS, mg/l)	Predicted Effluent Quality (BOD/TSS, mg/l)	Process Limitations Identified
Battle Ground, WA.	Rotating Biological Contactor	0.77	10/10	30/31	RBC's have inadequate treatment capacity. Aerobic digester very small
Coeur D'Alene, ID.	Single Stage Trickling Filter	3.0	30/30	29/29	Primary anaerobic digester very small
Gooding, ID.	Extended Aeration Oxidation Ditch	0.70	30/30	5/5	None
Grace, ID.	Extended Aeration Oxidation Ditch	0.29	30/30	5/5	None
Hansen, ID.	Extended Aeration Oxidation Ditch	0.125	30/30	5/8	None
Orofino, ID.	Extended Aeration Oxidation Ditch	0.88	30/30	5/11	None
Pullman, WA.	Activated Bio-Filter	6.0	30/30	5/10	None
Sequim, WA.	Extended Aeration Oxidation Ditch	0.725	30/30	5/5	None
St. Maries, ID.	Extended Aeration Oxidation Ditch	1.0	30/30	5/5	None
Sumner, WA.	Extended Aeration	2.6	30/30	63/98	Existing secondary clarifiers too shallow

in the programs and when interpreting the output.

1. In all of the programs, the average depth of primary and secondary clarifiers, based on total volume divided by surface area, should be used as a model input. Using the side water depth, particularly in circular secondary clarifiers, may lead to erroneous results.

2. The conventional activated sludge, single stage activated sludge for nitrification, contact stabilization, extended aeration, extended aeration oxidation ditch and activated bio-filter programs utilize a mixed liquor control methodology (described on page 3.1, item 3) which is intended to prevent solids overload of secondary clarifiers. It has been observed that when plants which utilize these processes and which have secondary clarifiers eight feet deep or less are modelled, the effluent quality predictions are extremely sensitive to the effects of this methodology. Slight changes in the depth of the clarifier or sludge blanket can produce marked changes in the predicted effluent quality. Evaluation of numerous treatment plants of this type indicate that this is, in fact, an accurate representation of actual performance. When simulating systems of this type, it is particularly important to have a thorough understanding of the actual operating characteristics of the plant in order to interpret the model's predictions in a meaningful way.

3. The Diagnostic Operational Modeling Programs predict the quality of secondary clarifier effluent. Effluent quality reported by most treatment plants is usually based on samples taken from the chlorine contact tank effluent. It has been repeatedly observed that chlorination can precipitate a significant fraction of the solids remaining in secondary clarifier effluent. This is particularly true in plants which produce a relatively poor quality effluent with a

high suspended solids concentration. This influence on final effluent quality must be evaluated by the program user.

2.4 Model Formats

Sample computer runs of the conventional activated sludge, extended aeration activated sludge, extended aeration oxidation ditch, activated bio filter, single stage trickling filter, two stage trickling filter, and rotating biological contactors computer programs are presented in Appendices A through G, respectively. The output format of the primary treatment program is identical to that of the primary clarification format in other programs. The output format of the single stage activated sludge for nitrification program is identical to that of the conventional activated sludge program.

CHAPTER 3

DIAGNOSTIC EVALUATIONS

3.1 General

In each of the 15 diagnostic evaluations conducted, treatment plants were modeled twice. The first modeling effort was conducted before an on-site inspection of the plant was made, and was intended primarily to establish the level of performance the plant should be able to achieve with all process units in operation. In order to establish standardized baseline conditions, the following assumptions were made in the preliminary runs:

1. In the Conventional Activated Sludge, Single Stage Activated Sludge for Nitrification, Activated Bio-Filter and Contact Stabilization programs, the maximum MLSS concentration in the biological reactors (contactor only in the Contact Stabilization program) is limited to 2500 mg/l.

2. In the Extended Aeration and Extended Aeration Oxidation Ditch programs, the maximum MLSS is limited to 3000 mg/l.

3. In all programs which simulate suspended growth reactors (all those included in items 1 and 2 above), the minimum allowable depth of the sludge blanket in secondary clarifiers is six feet measured from the water surface. This has an interactive effect on the mixed liquor concentration in the biological reactors. When the six foot depth is reached, this interaction causes the mixed liquor concentrations to be lowered to whatever level is necessary to maintain this six foot minimum as flows increase. The effects of this are generally quite noticeable when examining the output.

4. When actual data on certain wastewater characteristics was not available, typical values were used.

5. Performance was simulated at the average of the highest and lowest wastewater temperatures recorded annually. Where data was not available, plants were simulated at 15°C.

Following the on-site inspections, several models were calibrated to the actual conditions found in specific plants. This was accomplished by changing the plant configuration to reflect process units which had been taken off line, and by adjusting maximum mixed liquor concentrations and minimum sludge blanket depths in suspended growth systems to reflect the constraints of each system. In some plants, calibration was not required to simulate actual conditions.

In the following sections of this chapter, the effluent quality predictions of both the calibrated and uncalibrated models are compared to reported effluent quality. Steps required to calibrate the models to specific plants are described in detail. The calibrated models generally produced effluent quality predictions which were closer to actual plant performance, indicating that the program algorithms do produce realistic and accurate results over a wide range of operating conditions.

3.2 Aberdeen, Idaho Wastewater Treatment Plant

Data Summary

Biological Process - Extended Aeration
Design Flow (mgd) - 0.60
Actual Flow (mgd) - 0.32
Predicted Effluent Quality Before Calibration (BOD/TSS, mg/l) - 5/12
Actual Effluent Quality (BOD/TSS, mg/l) - 7/2
Predicted Effluent Quality After Calibration (BOD/TSS, mg/l) - 5/7

Background

The Aberdeen treatment plant was designed to use the activated bio-filter process followed by effluent filtration and chlorination. Effluent quality reported by the plant reflects these two processes which are not simulated by the diagnostic Operational Modeling Programs. There is little data available on the quality of secondary clarifier effluent.

For the last several months, the ABF tower has been shut down due to a severe plugging problem, and the plant is currently operating as an extended aeration plant. The effluent quality produced in this mode of operation is quite good, and there are no plans currently being made to bring the ABF tower back on line.

Diagnostic Evaluation Results

General. One visit was made to the Aberdeen treatment plant on 15 December, 1981 to evaluate operating conditions. At the time of the visit, the plant was operating well. All equipment except for the bio-tower appeared to be in good condition. Overall operation of the plant also appeared to be good.

Process Limitations. At the current hydraulic and organic loading, there are no significant process limitations. However, the depth of the secondary clarifier will probably limit overall plant performance during upsets and as flows approach the design flow of 0.6 mgd. However, the plant should be able to meet its discharge limit at design flow even if the bio-tower remains off line.

Operational Deficiencies. There were no operational deficiencies identified in the evaluation.

Model Accuracy. Since little data on effluent quality prior to filtration is available, it is difficult to assess the accuracy of the effluent quality predictions directly in this case. However, effluent quality observed during the on-site visit was very good, and subjectively appeared close to the models predictions. Solids loading on the effluent filters appeared to be very light.

Calibration of the model was accomplished by using the average depth of the secondary clarifier rather than the side wall depth and increasing the maximum MLSS concentration. The plant reported a maximum MLSS concentration of 3300 mg/l, which is roughly 10 percent higher than the calibrated model predicted could be achieved without overloading the secondary clarifier.

When the ABF tower was shut down at the Aberdeen treatment plant, very little change in final effluent quality was observed. It was therefore decided to simulate the operation of the plant with the ABF tower back on line and compare the predicted effluent quality - before filtration - with that predicted in the existing mode of operation. The results of this comparison are as follows:

Extended Aeration Mode

Predicted Effluent Quality Before Calibration (BOD/TSS, mg/l) - 5/12

Predicted Effluent Quality After Calibration (BOD/TSS, mg/l) - 5/7

Activated Bio-Filter Mode

Predicted Effluent Quality Before Calibration (BOD/TSS, mg/l) - 5/8

Predicted Effluent Quality After Calibration (BOD/TSS, mg/l) - 5/5

Calibration of the ABF program was accomplished in the same way as in the extended aeration program. The models predict that there would be virtually no difference between the effluent quality that

could be achieved in the two modes of operation. Actual plant data indicate that this prediction is essentially correct.

Recommendations. No recommendations were made regarding process limitations or operational deficiencies. The calibrated model indicated that the system mean cell resident time was sufficiently high (>30 days) that aerobic sludge digestion should not be required. Plant data also indicated that little or no volatile solids reduction occurred in the digester. It was, therefore, recommended that consideration be given to shutting down the digester to reduce operating costs.

ABERDEEN, IDAHO WASTEWATER TREATMENT PLANT
WASTEWATER CHARACTERIZATION AND PLANT CONFIGURATION DATA

WASTEWATER CHARACTERIZATION

Average Dry Weather Flow	mgd:	.32
Peak Dry Weather Flow	mgd:	.4
Design Flow	mgd:	.6
Influent BOD	mg/l:	150
Influent TSS	mg/l:	225
Influent VSS	(%):	45
Temperature	°C:	15
TKN	mg/l:	13.7
Alkalinity	mg/l:	100*
pH	:	8
PO4-P	mg/l:	8*

*No actual data available. Typical values used.

PLANT CONFIGURATION AND DIMENSIONS

Bio Tower

Media type: redwood
Constant flow
Number of bio towers: 1
Dimensions:

Length	(ft):	20
Width	(ft):	20
Depth	(ft):	14
Flow rate	(gpm):	850

Aeration Basin

Number of rectangular reactors: 1
Dimensions:

Length	(ft):	80
Width	(ft):	80
Depth	(ft):	14

Secondary Clarification

Number of round clarifiers: 1
Dimensions:

Diameter	(ft):	35
Depth	(ft):	8.5
Weir length	(ft):	109

Sludge Handling

Type of digestion: aerobic
Number of digesters: 1
Volume (gal): 150,000

could be achieved in the two modes of operation. Actual plant data indicate that this prediction is essentially correct.

Recommendations. No recommendations were made regarding process limitations or operational deficiencies. The calibrated model indicated that the system mean cell resident time was sufficiently high (>30 days) that aerobic sludge digestion should not be required. Plant data also indicated that little or no volatile solids reduction occurred in the digester. It was, therefore, recommended that consideration be given to shutting down the digester to reduce operating costs.

ABERDEEN, IDAHO WASTEWATER TREATMENT PLANT
WASTEWATER CHARACTERIZATION AND PLANT CONFIGURATION DATA

WASTEWATER CHARACTERIZATION

Average Dry Weather Flow	mgd:	.32
Peak Dry Weather Flow	mgd:	.4
Design Flow	mgd:	.6
Influent BOD	mg/l:	150
Influent TSS	mg/l:	225
Influent VSS	(%):	45
Temperature	°C:	15
TKN	mg/l:	13.7
Alkalinity	mg/l:	100*
pH	:	8
PO4-P	mg/l:	8*

*No actual data available. Typical values used.

PLANT CONFIGURATION AND DIMENSIONS

Bio Tower

Media type: redwood
Constant flow
Number of bio towers: 1
Dimensions:

Length	(ft):	20
Width	(ft):	20
Depth	(ft):	14
Flow rate	(gpm):	850

Aeration Basin

Number of rectangular reactors: 1
Dimensions:

Length	(ft):	80
Width	(ft):	80
Depth	(ft):	14

Secondary Clarification

Number of round clarifiers: 1
Dimensions:

Diameter	(ft):	35
Depth	(ft):	8.5
Weir length	(ft):	109

Sludge Handling

Type of digestion: aerobic
Number of digesters: 1
Volume (gal): 150,000

3.3 American Falls, Idaho Wastewater Treatment Plant

Data Summary

Biological Process - Single Stage Trickling Filter
Design Flow (mgd) - 0.90
Actual Flow (mgd) - 0.37
Predicted Effluent Quality (BOD/TSS, mg/l) - 20/24
Actual Effluent Quality (BOD/TSS, mg/l) - 60/45

Background

The American Falls treatment plant is a single stage trickling filter plant which is currently being expanded. Much of the equipment in the plant is old and near the end of its useful service life. Effluent quality is consistently in violation of the plant's BOD and TSS requirements.

Diagnostic Evaluation Results

General. One visit was made to the American Falls treatment plant on 17 September, 1981 to evaluate operating conditions. At the time of the visit, the ongoing construction was not interfering excessively with normal operation of the plant. Considering the age of the equipment, the plant appeared to be well operated and maintained.

Process Limitations. The secondary sludge pump is near the point of failure. Since there is no standby pump, the unit is only operated a few hours each day. This allows sludge to accumulate in the clarifier for long periods of time which often results in considerable solids loss. This problem, unfortunately, cannot be corrected.

Operational Deficiencies. There were no operational deficiencies identified in the evaluation.

Model Accuracy. The model predicted that under ideal conditions the plant could produce a significantly better quality effluent than it was. However, the process limitation which was identified can easily account for the difference. It is, therefore, difficult to assess the accuracy of the effluent quality predictions in this case. The model did, however,

predict that with the existing wastewater characteristics, the plant would probably not be able to meet its discharge limits consistently at flows significantly higher than the existing average flow even if the existing deficiencies were corrected. No calibration of the model was considered necessary in this case.

Recommendations. As an expansion of the American Falls treatment plant is currently in progress which will correct existing process limitations and no operation deficiencies were identified, no recommendations were made as a result of this plant evaluation.

AMERICAN FALLS, IDAHO WASTEWATER TREATMENT PLANT
WASTEWATER CHARACTERIZATION AND PLANT CONFIGURATION DATA

WASTEWATER CHARACTERIZATION

Average Dry Weather Flow	mgd:	.37
Peak Dry Weather Flow	mgd:	.45
Design Flow	mgd:	.9
Influent BOD	mg/l:	180
Influent TSS	mg/l:	180
Influent VSS	(%):	67
Temperature	°C:	15
TKN	mg/l:	27.7
Alkalinity	mg/l:	100*
pH	:	7.3
PO4-P	mg/l:	37.1

*No actual data available. Typical values used.

PLANT CONFIGURATION AND DIMENSIONS

Primary Clarification

Number of round clarifiers: 1
Dimensions:
- Diameter (ft): 28
- Depth (ft): 7.5
- Weir length (ft): 88

Trickling Filter

Media type: rock
Constant recirculation
Number of trickling filters: 1
Dimensions:
- Diameter (ft): 40
- Depth (ft): 6.5
- Recirc. rate (gpm): 200

Secondary Clarification

Number of round clarifiers: 1
Dimensions:
- Diameter (ft): 28
- Depth (ft): 7.5
- Weir length (ft): 88

Sludge Handling

Type of digestion: anaerobic
Number of primary digesters: 1
Volume (gal): 46,800

3.4 Caldwell, Idaho Wastewater Treatment Plant

Data Summary - First Evaluation

Biological Process - Single Stage Trickling Filter
Design Flow (mgd) - 7.78
Actual Flow (mgd) - 3.80
Predicted Effluent Quality (BOD/TSS, mg/l) - 32/32
Actual Effluent Quality (BOD/TSS, mg/l) - 46/33

Data Summary - Second Evaluation

Biological Process - Two Stage Trickling Filter
Design Flow (mgd) - 7.78
Actual Flow (mgd) - 3.20
Predicted Effluent Quality (BOD/TSS, mg/l) - 17/17
Actual Effluent Quality (BOD/TSS, mg/l) - 25/33

Background

The Caldwell treatment plant was originally designed as a single stage, rock media trickling filter plant which was later expanded by adding an additional deep tower trickling filter with stacked plastic media. The plastic media in the new bio-tower failed structurally soon after being put on line and the plant was again operating in the single stage mode at the time of the first on-site visit. The bio-tower media was subsequently repaired and was put back in operation about one month before the second visit was made.

The plant is equpped with effluent filters and chlorination facilities, which are not simulated by the Diagnostic Operational Modeling Programs. There is little data available on the quality of secondary clarifier effluent.

Diagnostic Evaluation Results

General. Visits were made to the plant on 14 September and 9 December 1981 to evaluate operating conditions. During both visits, the plant was violating its monthly average TSS discharge requirement by 3 mg/l. During the first visit the plant was also violating its

monthly average BOD requirement by 16 mg/l. All equipment in operation during both visits appeared to be in good condition. Overall operation of the plant also appeared to be good.

The plant receives a significant portion of its waste flow from commercial meat processing and creamery facilities and the wastewater was very strong. No data was available on BOD or TSS removal in the primary clarifiers which could be used to verify the predicted removal efficiencies.

Process Limitations. No process limitations were identified during either of the on-site visits. However, time did not allow pan tests to be conducted on either of the trickling filters to verify the uniformity of flow distribution. This should be a priority in subsequent evaluation efforts. The model did, however, predict that even under ideal operating conditions, the plant would not be able to meet its discharge limit at design flow with the existing wastewater characteristics. The treatment capacity of the two trickling filters was identified as the limiting factor in overall plant performance.

Operational Deficiencies. There were no operational deficiencies identified in the evaluation.

Model Accuracy. The model predicted significantly better effluent quality than was observed during the evaluation. This indicates that either the treatability characteristics of the waste are significantly different from those of typical domestic wastewater, or that a process limitation exists which could not be identified during the on-site evaluations due to time constraints. Calibration of the model was not considered feasible without this information.

Recommendations. No recommendations were made regarding process limitations or operational deficiencies as part of this plant evaluation.

CALDWELL, IDAHO WASTEWATER TREATMENT PLANT
WASTEWATER CHARACTERIZATION AND PLANT CONFIGURATION DATA

WASTEWATER CHARACTERIZATION

Average Dry Weather Flow	mgd:	3.8
Peak Dry Weather Flow	mgd:	5.0
Design Flow	mgd:	7.78
Influent BOD	mg/l:	325
Influent TSS	mg/l:	396
Influent VSS	(%):	80*
Temperature	°C:	17
TKN	mg/l:	30*
Alkalinity	mg/l:	100*
pH	:	7*
PO4-P	mg/l:	8*

*No actual data available. Typical values used.

PLANT CONFIGURATION AND DIMENSIONS

Primary Clarification

Number of round clarifiers: 1
Dimensions:
- Diameter (ft): 110
- Depth (ft): 8.75
- Weir length (ft): 345

Trickling Filters

Primary Filter
Media type: rock
Number of trickling filters: 1
Dimensions:
- Diameter (ft): 140
- Depth (ft): 6.33
- Recirc. rate (gpm): 10,400

Secondary Filter
Media type: stacked plastic
Number of trickling filters: 1
Dimensions:
- Diameter (ft): 50
- Depth (ft): 19
- Recir. rate (gpm): 8,400

Secondary Clarification

Number of round clarifiers: 2
Dimensions, each:
- Diameter (ft): 110
- Depth (ft): 8
- Weir length (ft): 345

Sludge Handling

Sludge thickening: yes
Type: gravity
Type of digestion: anaerobic
Number of primary digesters: 1
Volume (gal): 151,000
Number of secondary digesters: 1
Volume (gal): 144,000

3.5 Centralia, Washington Wastewater Treatment Plant

Data Summary - First Evaluation

Biological Process - Single Stage Trickling Filter
Design Flow (mgd) - 4.3
Actual Flow (mgd) - 1.48
Predicted Effluent Quality (BOD/TSS, mg/l) - 7/7
Actual Effluent Quality (BOD/TSS, mg/l) - 20/28

Data Summary - Second Evaluation

Biological Process - Single Stage Trickling Filter
Design Flow (mgd) - 4.3
Actual Flow (mgd) - 3.2
Predicted Effluent Quality (BOD/TSS, mg/l) - 14/15
Actual Effluent Quality (BOD/TSS, mg/l) - 24/17

Background

The Centralia treatment plant is a conventional single stage, rock media trickling filter plant which has experienced compliance difficulties in recent years, particularly with respect to the 85 percent BOD and TSS removal requirements established in the plant's NPDES permit. The plant operates well under design organic and hydraulic loadings during most of the year. During winter months, I/I problems result in high flows of very dilute wastewater reaching the plant.

Diagnostic Evaluation Results

General. Visits were made to the plant on 2 September and 16 December 1981 to evaluate operating conditions. During both visits, the plant was operating relatively well, and all equipment appeared to be in good condition. Laboratory data was minimal, and was considered insufficient for optimum process control.

Process Limitations. Preliminary inspection of the trickling filters indicated that flow distribution over one of the filters was extremely uneven. Moreover, there was no way to accurately measure the flow split between the two filters. Pan tests were conducted during the second visit which confirmed the fact that flow distribution over both trickling filters was very uneven. Adjustments were made to the distributor arms until subsequent tests indicated that the most even distribution possible had been achieved.

Operational Deficiencies. During the second visit, plant staffing and individual responsibilities were discussed with the plant's chief operator. It became evident that the plant was seriously understaffed. This resulted in laboratory and process control work being given a very low priority to the detriment of overall plant performance.

Model Accuracy. Initially, the model indicated that the plant could produce a much better effluent than it was. Correction of the process limitations identified in the evaluation, and slight calibration of the model by eliminating one primary clarifier which had been taken off line, resulted in actual effluent quality in recent months that is much closer to the calibrated model's performance.

Recommendations. It was recommended that additional operators and a full time laboratory technician be provided to improve process control work at the plant. It was also recommended that pan tests be repeated at regular intervals to ensure that flow distribution over the filters remain even as plant flows and recycle rates change seasonally.

CENTRALIA, WASHINGTON WASTEWATER TREATMENT PLANT WASTEWATER CHARACTERIZATION AND PLANT CONFIGURATION DATA

WASTEWATER CHARACTERIZATION

Average Dry Weather Flow	mgd:	1.48
Peak Dry Weather Flow	mgd:	3.26
Design Flow	mgd:	4.3
Influent BOD	mg/l:	148
Influent TSS	mg/l:	158
Influent VSS	(%):	80*
Temperature	°C:	15
TKN	mg/l:	30*
Alkalinity	mg/l:	100*
pH	:	6.9
PO4-P	mg/l:	8*

*No actual data available. Typical values used.

PLANT CONFIGURATION AND DIMENSIONS

Primary Clarification

Number of rectangular clarifiers: 5
Dimensions, each:

Length	(ft):	68
Width	(ft):	15.5
Depth	(ft):	6
Weir length	(ft):	15.5

Trickling Filters

Media type: rock
Constant recirculation
Number of trickling filters: 2
Dimensions:

		#1	#2
Diameter	(ft):	68	85
Depth	(ft):	6	8
Recirc. rate	(gpm):	1,300	2,000

Secondary Clarification

Number of round clarifiers: 2
Dimensions, each:

Diameter	(ft):	70
Depth	(ft):	8
Weir length	(ft):	220

Sludge Handling

Type of digestion: anaerobic
Number of primary digesters: 1
Volume (gal): 247,000
Number of secondary digesters: 1
Volume (gal): 186,500

3.6 Gig Harbor, Washington Wastewater Treatment Plant

Data Summary - First and Second Evaluations

Biological Process - Conventional Activated Sludge
Design Flow (mgd) - 0.45
Actual Flow (mgd) - 0.235
Predicted Effluent Quality Before Calibration (BOD/TSS, mg/l) - 68/89
Actual Effluent Quality (BOD/TSS, mg/l) - 22/27
Predicted Effluent Quality After Calibration (BOD/TSS, mg/l) 24/31

Background

The Gig Harbor treatment plant is a relatively small conventional activated sludge plant which is typical in most respects. The plant experiences few compliance problems. Flows at night are extremely low, making the diurnal flow variation unusually high.

Diagnostic Evaluation Results

General. Visits were made to the plant on 3 September and 17 December 1981 to evaluate operating conditions. During the first visit, solids loss was occurring from the chlorine contact tank and effluent quality was poor. During the second visit, the tank had been cleaned and effluent quality was much better. All equipment in the plant appeared to be in good condition, and overall operation of the plant also appeared to be good.

Process Limitations. The aeration system at the Gig Harbor plant had marginal oxygen transfer capacity and was extremely inefficient during the first visit. A retrofit was in progress at that time to correct those deficiencies. The uncalibrated model also predicted that the depth of the secondary clarifiers was inadequate for existing conditions, although this limitation was not evident during either visit. Calibration of the model to actual conditions indicated that this limitation would become pronounced if flows increased significantly.

Operational Deficiencies. There were no operational deficiencies identified during either of the plant visits.

Model Accuracy. The model was calibrated to actual conditions by increasing the maximum MLSS concentration to 3300 mg/l and using the average clarifier depth of 11 feet rather than the side water depth of approximately 8.5 feet. The calibrated model simulated the actual performance of the plant very accurately. It did, however, predict that the plant was near the point of failure, even though flows were considerably lower than the design flow. It has been observed that effluent quality predictions made under these condtions are very sensitive to minor changes in certain parameters. However, the model does indicate that the plant will not be able to meet its discharge limit at the design flow with the existing wastewater characteristics.

Recommendations. No recommendations regarding process limitations or operational deficiencies were made as a result of this evaluation.

GIG HARBOR, WASHINGTON WASTEWATER TREATMENT PLANT
WASTEWATER CHARACTERIZATION AND PLANT CONFIGURATION DATA

WASTEWATER CHARACTERIZATION

Average Dry Weather Flow	mgd:	.235
Peak Dry Weather Flow	mgd:	.25
Design Flow	mgd:	.45
Influent BOD	mg/l:	312
Influent TSS	mg/l:	183
Influent VSS	(%):	92
Temperature	°C:	15
TKN	mg/l:	30*
Alkalinity	mg/l:	100*
pH	:	7.4
PO4-P	mg/l:	8*

*No actual data available. Typical values used.

PLANT CONFIGURATION AND DIMENSIONS

Aeration Basins

Number of rectangular basins: 2
Dimensions, each:

Length	(ft):	18
Width	(ft):	18
Depth	(ft):	16

Secondary Clarification

Number of round clarifiers: 2
Dimensions, each:

Diameter	(ft):	23
Depth	(ft):	11
Weir length	(ft):	72

Sludge Handling

Type of digestion: aerobic
Number of digesters: 1
Volume (gal): 80,784

3.7 Idaho Falls, Idaho Wastewater Treatment Plant

Data Summary

Biological Process - Activated Bio-filter

Design Flow (mgd) - 17.0

Actual Flow (mgd) - 6.8

Predicted Effluent Quality Before Calibration (BOD/TSS, mg/l) - 5/5

Actual Effluent Quality (BOD/TSS, mg/l) - 6/7

Predicted Effluent Quality After Calibration (BOD/TSS, mg/l) - 5/6

Background

The Idaho Falls treatment plant uses the activated bio-filter process and was designed to treat a high proportion of food processing wastes. Many of the commercial entities which were expected to produce these wastes are not yet in operation, and loading on the plant is relatively light. Effluent quality is usually very good.

Diagnostic Evaluation Results

General. One visit was made to the Idaho Falls treatment plant on 14 December 1981 to evaluate operating conditions. At the time of the visit, the plant was operating well. All equipment appeared to be in good condition. One aerating basin and one secondary clarifier had been taken off line to reduce operating costs.

Process Limitations. There were no process limitations identified in the evaluation.

Operational Deficiencies. There were no operational deficiencies identified in the evaluation.

Model Accuracy. The model's effluent quality predictions matched the plant's actual performance almost exactly both before and after calibration. Calibration was accomplished by simulating only one aeration basin and one secondary clarifier, and by increasing the maximum MLSS concentration to 2800 mg/l. The average depths of both the primary and secondary clarifiers were used in both runs. The output indicated that with all process units in operation, the Idaho Falls treatment plant should be able to meet its discharge limit at design flow with the

existing wastewater characteristics.

Recommendations. No recommendations regarding process limitations or operational deficiencies were made as a result of this evaluation.

IDAHO FALLS WASTEWATER TREATMENT PLANT
WASTEWATER CHARACTERIZATION AND PLANT CONFIGURATION DATA

WASTEWATER CHARACTERIZATION

Average Dry Weather Flow	mgd:	6.8
Peak Dry Weather Flow	mgd:	9.3
Design Flow	mgd:	17
Influent BOD	mg/l:	176
Influent TSS	mg/l:	174
Influent VSS	(%):	83
Temperature	°C:	12
TKN	mg/l:	30*
Alkalinity	mg/l:	100*
pH	:	7.4
PO4-P	mg/l:	8*

*No actual data available. Typical values used.

PLANT CONFIGURATION AND DIMENSIONS

Primary Clarification

Number of rectangular clarifiers: 1
Dimensions:

Diameter	(ft):	110
Depth	(ft):	10
Weir length	(ft):	346

Bio Filter

Media type: redwood
Constant flow
Number of bio towers: 1
Dimensions:

Diameter	(ft):	132
Depth	(ft):	21.5
Flow rate	(gpm):	18,750

Aeration Basins

Number of rectangular basins: 2
Dimensions, each:

Length	(ft):	120
Width	(ft):	120
Depth	(ft):	14

Secondary Clarification

Number of round clarifiers: 2
Dimensions, each:

Diameter	(ft):	130
Depth	(ft):	14
Weir length	(ft):	408

Sludge Handling

Sludge thickening: yes
Type: centrifuge
Type of digestion: anaerobic
Number of primary digesters: 2

	#1	#2
Volume (gal):	11,250,000	11,250,000

Number of secondary digesters: 2

	#1	#2
Volume (gal):	300,000	300,000

3.8 Ketchum, Idaho Wastewater Treatment Plant

Data Summary

Biological Process - Extended Aeration
Design Flow (mgd) - 2.25 (1.5 in NPDES permit)
Actual Flow (mgd) - 0.72
Predicted Effluent Quality Before Calibration (BOD/TSS, mg/l) - 5/5
Actual Effluent Quality (BOD/TSS mg/l) - 10/25
Predicted Effluent Quality After Calibration (BOD/TSS, mg/l) - 5/5

Background

The Ketchum treatment plant uses the extended aeration process to treat typical domestic wastewater from a community with heavy seasonal tourist influence. The plant discharges to a high quality stream, and phosphorus removal is required. This is accomplished by adding lime to the aeration basin effluent. The long mean cell residence time in the system results in considerable accumulation of alum, and MLSS concentrations typically range from 5,000 to 6,000 mg/l. Polymer is used on a continuous basis to aid sludge settling in the secondary clarifiers. Occasional phosphorus violations are reported.

Diagnostic Evaluation Results

General. Two visits were made to the Ketchum treatment plant on 16 September and 11 December, 1981. At the time of both visits, the plant was operating well. All equipment appeared to be in good condition.

Process Limitations. Overall, the plant is somewhat lacking in flexibility and instrumentation needed to balance flows between parallel process units. This is particularly important with high mixed liquor concentrations. A much more significant limitation exists in one of the two secondary clarifiers. One clarifier utilizes a circular collector mechanism in an essentially rectangular basin. The collector is equipped with sweep arms to remove sludge from the corners of the basin. This system creates a considerable amount of turbulance and results in near continuous loss of floc from the corners of the clarifier. The other secondary clarifier, which is a conventional circular unit, does

not experience this problem. Therefore, the flow split between these units has been adjusted to load the conventional circular clarifier more heavily than the other unit, to minimize solids loss.

Operational Deficiencies. Polymer use is a very important aspect of successful operation of the Ketchum treatment plant. Unfortunately, few manufacturers have expressed an interest in testing or supplying their products in reasonable quantities. The purpose of the second plant visit was to test several types of polymer which might prove more effective than the one currently in use. Although conclusions cannot be drawn from one day's testing, the results strongly indicated that more effective and possibly less expensive polymers may be available.

Model Accuracy. Both the calibrated and uncalibrated models indicated that under ideal conditions the plant could produce a better quality effluent than it was. Calibration of the model was accomplished by allowing a maximum MLSS concentration of 6,000 mg/l. The calibrated model indicated that MLSS concentrations greater than 4,000 mg/l would overload the clarifiers. However, the models do not account for the effects of polymer addition, and were not intended to be applied directly to atypical (i.e., high alum content) sludges. The results of the modeling and on-site evaluation indicate that the process limitations in the secondary clarifier system are lowering the overall performance of the plant significantly. If this deficiency is corrected, the models indicate that the plant should be able to meet its discharge limit at design flow with the existing wastewater characteristics.

Recommendations. As an upgrade of the plant is currently under consideration, no recommendations were made regarding correction of existing process limitations. It was recommended that additional polymer testing be conducted, both on a bench scale and in full scale operation to improve existing effluent quality.

KETCHUM WASTEWATER TREATMENT PLANT
WASTEWATER CHARACTERIZATION AND PLANT CONFIGURATION DATA

WASTEWATER CHARACTERIZATION

Average Dry Weather Flow	mgd:	.72
Peak Dry Weather Flow	mgd:	1.27
Design Flow	mgd:	1.5
Influent BOD	mg/l:	132
Influent TSS	mg/l:	93
Influent VSS	(%):	80*
Temperature	°C:	15
TKN	mg/l:	30*
Alkalinity	mg/l:	100*
pH	:	7*
PO4-P	mg/l:	5.2

*No actual data available. Typical values used.

PLANT CONFIGURATION AND DIMENSIONS

Aeration Basins

Number of rectangular basins: 2
Dimensions, each:

Length	(ft):	100
Width	(ft):	50
Depth	(ft):	12.5

Secondary Clarification

Number of round clarifiers: 2
Dimensions:

		#1	#2
Diameter	(ft):	45	55
Depth	(ft):	10.25	12.75
Weir length	(ft):	141	220

Sludge Handling

Type of digestion: aerobic
Number of digesters: 1
Volume (gal): 300,000

3.9 Lander Street (Boise) Idaho Wastewater Treatment Plant

Data Summary

Biological Process - Conventional Activated Sludge
Design Flow (mgd) - 15.0
Actual Flow (mgd) - 9.1
Predicted Effluent Quality Before Calibration (BOD/TSS, mg/l) - 5/6
Actual Effluent Quality (BOD/TSS, mg/l) - 8/14
Predicted Effluent Quality After Calibration (BOD/TSS, mg/l) - 7/10

Background

The Lander Street treatment plant in Boise, Idaho, is a conventional activated sludge plant which generally produces a good quality effluent. However, the plant has repeatedly experienced problems with filamentous bacterial growth and minor upsets are unusually frequent.

Diagnostic Evaluation Results

General. Two visits were made to the Lander Street plant on 15 September and 9 December 1981 to evaluate operating conditions. At the time of both visits, the plant was operating well. All equipment appeared to be in good condition.

Process Limitations. Several process limitations were evident at the Lander Street plant. There was considerable turbulence in the influent end of the primary clarifiers. The oxygen transfer capacity of the aeration system was marginal, and limited the maximum MLSS concentration to 1700 mg/l. Two of the three circular secondary clarifiers had the same diameter, but different depths. The third was both the largest and deepest. The operators indicated that the best overall performance was achieved by loading the largest (and deepest) clarifier very heavily and loading the shallowest clarifier very lightly. However, there was no way to measure the flow split between these three units. Finally, there were several indications of hydraulic overload in the secondary clarifier effluent collection systems and in the chlorine contact system, which interfered with efforts to control hydraulic balance in the secondary clarifiers as flows varied through the day.

Operational Deficiencies. By carefully reviewing the plant's laboratory data and comparing it to the output of the model, a number of anomalies related to control of the biological system were identified. These were traced to the location of the primary effluent sampling point which was downstream of the subnatent return flows from the plant's DAF thickener. Excessive solids loss from this unit was being interpreted as erroneously high BOD concentrations in the primary effluent. Solids lost from the DAF thickener are active biological floc, which actually contribute no organic load to the secondary system.

Model Accuracy. Effluent quality predictions made with the uncalibrated model were relatively close to the actual performance of the plant. Later predictions made with the calibrated model were very close to actual performance. Calibration was achieved by limiting the maximum MLSS concentration to 1700 mg/l. Examination of both runs indicated that at the present time, the relatively low MLSS concentrations were not limiting overall plant performance significantly. This would, however, make the plant's ability to meet its discharge limit marginal at flows near the design flow with the existing wastewater characteristics. Apparently the limitations imposed by the secondary clarifier system do not limit overall plant performance significantly at the present time, although the lack of instrumentation makes it impossible to evaluate this problem quantitatively, or predict its impact at higher flows. The models indicated that under ideal conditions, the plant should be able to meet its discharge limit at design flow with the present wastewater characteristics if oxygen transfer capacity can be increased to allow a maximum MLSS concentration of about 2500 mg/l.

Recommendations. It was recommended after the first plant visit that the primary effluent sampling point be relocated upstream of the DAF subnatent return, that the RAS be chlorinated to control filamentous growth, and that baffles be constructed in the primary clarifiers to reduce turbulence and improve settling. When the second visit was made, the first two recommendations had been implemented. Chlorination of the RAS reduced SVI's from over 200 to less than 100 within 24 hours, which improved solids handling in the secondary clarifiers. The

operators also believed that improved sampling had resulted in more stable operation. The addition of baffles in the primary clarifiers was being considered. Retrofitting of the aeration system to improve oxygen transfer was also being considered.

LANDER STREET, IDAHO WASTEWATER TREATMENT PLANT
WASTEWATER CHARACTERIZATION AND PLANT CONFIGURATION DATA

WASTEWATER CHARACTERIZATION

Average Dry Weather Flow	mgd:	9.1
Peak Dry Weather Flow	mgd:	12.2
Design Flow	mgd:	15
Influent BOD	mg/l:	173
Influent TSS	mg/l:	202
Influent VSS	(%):	80*
Temperature	°C:	15
TKN	mg/l:	30*
Alkalinity	mg/l:	100*
pH	:	6.8
PO4-P	mg/l:	8*

*No actual data available. Typical values used.

PLANT CONFIGURATION AND DIMENSIONS

Primary Clarification

Number of rectangular clarifiers: 5
Dimensions, each:

Length	(ft):	94
Width	(ft):	20
Depth	(ft):	11.5
Weir length	(ft):	20

Aeration Basins

Number of rectangular basins: 4
Dimensions, each:

Length	(ft):	225
Width	(ft):	30
Depth	(ft):	15

Secondary Clarification

Number of round clarifiers: 3
Dimensions:

		#1	#2	#3
Diameter	(ft):	90	90	135
Depth	(ft):	12	10	15
Weir length	(ft):	282	282	424

Sludge Handling

Sludge thickening: yes
Type: DAF
Type of digestion: anaerobic
Number of primary digesters: 2

	#1	#2
Volume (gal):	998,000	998,000

Number of secondary digesters: 3

	#1	#2	#3
Volume, (gal):	489,000	489,000	489,000

3.10 Meridian, Idaho Wastewater Treatment Plant

Data Summary

Biological Process - Activated Bio-Filter

Design Flow (mgd) - 2.82

Actual Flow (mgd) - 2.04

Predicted Effluent Quality Before Calibration (BOD/TSS, mg/l) - 5/6

Actual Effluent Quality (BOD/TSS, mg/l) - 5/5

Predicted Effluent Quality After Calibration (BOD/TSS, mg/l) - 5/11

Background

The Meridian treatment plant went on line as a completely new plant. Considerable difficulty was encountered in the first year of operation with the traveling and bridge type sludge collectors in the secondary clarifiers. These units are now working well, and effluent quality has consistently been good.

Diagnostic Evaluation Results

General. One visit was made to the Meridian plant on 10 December, 1981. At the time of the visit, the plant was operating well. All equipment appeared to be in good condition. One primary clarifier and one aeration basin had been taken off line to reduce operating costs.

Process Limitations. There were no process limitations identified in the evaluation.

Operational Deficiencies. There were no operational deficiencies identified in the evaluation.

Model Accuracy. Both the calibrated and uncalibrated models produced effluent quality predictions that were very close to the actual performance of the plant. However, the uncalibrated model's predictions were slightly closer. Calibration of the model was accomplished by removing one primary clarifier and one aeration basin from service, and allowing a maximum MLSS concentration of 2800 mg/l. Examination of several calibration runs with various other assumptions indicated that the overall performance of the plant is particularly

sensitive to the depth of the secondary clarifiers and the thickness of the sludge blanket at flows near the existing flow. Subsequent discussions with plant operators indicated that the significant intermediate operating parameters predicted by the program were quite accurate. Therefore, the model indicates that the performance of the plant may soon become unstable and make it necessary to bring all process units on line in order to produce an acceptable effluent. The model did indicate that the plant should be able to meet its discharge limit at design flow with the existing wastewater characteristics if all units are kept on line.

Recommendations. No recommendations were made regarding process limitations or operational deficiencies as a result of this project.

MERIDIAN, IDAHO WASTEWATER TREATMENT PLANT
WASTEWATER CHARACTERIZATION AND PLANT CONFIGURATION DATA

WASTEWATER CHARACTERIZATION

Average Dry Weather Flow	mgd:	2.04
Peak Dry Weather Flow	mgd:	2.5
Design Flow	mgd:	2.82
Influent BOD	mg/l:	108
Influent TSS	mg/l:	153
Influent VSS	(%):	80*
Temperature	°C:	15
TKN	mg/l:	35.5
Alkalinity	mg/l:	100*
pH	:	7.7
PO4-P	mg/l:	8*

*No actual data available. Typical values used.

PLANT CONFIGURATION AND DIMENSIONS

Primary Clarification

Number of rectangular clarifiers: 2
Dimensions, each:

Diameter	(ft):	40
Depth	(ft):	8
Weir length	(ft):	26

Bio Tower

Media type: redwood
Constant recirculation
Number of bio towers: 1
Dimensions:

Length	(ft):	56
Width	(ft):	24
Depth	(ft):	14
Recirc. rate	(gpm):	2,500

Aeration Basins

Number of rectangular basins: 2
Dimensions, each:

Length	(ft):	64
Width	(ft):	34
Depth	(ft):	14

Secondary Clarification

Number of rectangular clarifiers: 2
Dimensions, each:

Length	(ft):	96
Width	(ft):	24
Depth	(ft):	8
Weir length	(ft):	80

Sludge Handling

Sludge thickening: yes
Type: DAF
Type of digestion: anaerobic
Number of primary digesters: 1
Volume (gal): 130,000
Number of secondary digesters: 1
Volume (gal): 130,000

3.11 Monroe, Washington Wastewater Treatment Plant

Data Summary

Biological Process - Rotating Biological Contactors
Design Flow (mgd) - 1.40
Actual Flow (mgd) - 0.50
Predicted Effluent Quality (BOD/TSS, mg/l) - 57/60
Actual Effluent Quality (BOD/TSS, mg/l) - 36/10

Background

The Monroe treatment plant uses rotating biological contactors to treat a combination of municipal and institutional wastewater. Pretreatment was recently added at the major institutional source to reduce organic loading fluctuations. The plant's effluent quality is frequently in violation of its NPDES permit requirements.

Diagnostic Evaluation Results

General. One visit was made to the Monroe treatment plant on 31 August, 1981 to evaluate operating conditions. At the time of the visit, the plant was operating well, although it was not in compliance. Most equipment was in good condition, although some mechanical maintenance needs were evident.

Process Limitations. The model predicted that the treatment capacity of the RBC units would limit the overall performance of the plant at the existing flow and with the existing wastewater characteristics to the extent that it would not be able to meet its discharge limit. There was no way to measure the flow split between the two RBC trains, although the flow split appeared to be very uneven. The RBC media was covered with a very heavy slime growth for the entire length of both trains. There was a significant amount of turbulence at the influent end of the secondary clarifiers. The level of the effluent weirs was also noticeably uneven. There was no way to measure the flow split between the two clarifiers.

Operational Deficiencies. There were no operational deficiencies identified in the evaluation.

Model Accuracy. The model predicted higher effluent BOD and much higher effluent TSS concentrations than the plant reported. One prediction in the model which could account for this difference is the BOD and TSS removal across the fine screens in the plant headworks. There was no data available to verify the predicted removals. Thus the predicted loadings on the secondary system may have been somewhat in error. The model did, however, predict that the plant would not be able to meet its discharge limit at the existing flow and that effluent quality would continue to deteriorate as flows increased. There was not enough data available to allow calibration of the model.

Recommendations. It was recommended that dye tests be conducted to balance the flow to the two RBC trains and clarifiers. It was also recommended that influent baffles be constructed in the clarifiers to reduce turbulence if their performance becomes unacceptable.

The aerobic digester system is very conservatively sized, and it was recommended that, if possible, part of the system be shut down to reduce energy costs. It was also recommended that a lower horsepower aerator system be considered for the portion of the system left on line to further reduce energy costs.

MONROE, WASHINGTON WASTEWATER TREATMENT PLANT
WASTEWATER CHARACTERIZATION AND PLANT CONFIGURATION DATA

WASTEWATER CHARACTERIZATION

Average Dry Weather Flow	mgd:	.5
Peak Dry Weather Flow	mgd:	.6
Design Flow	mgd:	1.4
Influent BOD	mg/l:	206
Influent TSS	mg/l:	186
Influent VSS	(%):	80*
Temperature	°C:	15
TKN	mg/l:	30
Alkalinity	mg/l:	100*
pH	:	7
PO4-P	mg/l:	8*

*No actual data available. Typical values used.

PLANT CONFIGURATION AND DIMENSIONS

Influent Fine Screens

Number of screens: 3
Width (ft): 5
Height (ft): 5
Screen opening (in.): .06
Capacity each (mgd): 2.1
Total capacity (mgd): 6.3

Rotating Biological Contactors

Type: mechanical drive
Number of process trains: 2
Number of shafts per train: 2
Shaft #1 surface area (ft2): 96,000
Shaft #2 surface area (ft2): 96,000

Secondary Clarification

Number of rectangular clarifiers: 2
Dimensions, each:

Length	(ft):	76.3
Width	(ft):	16.7
Depth	(ft):	10
Weir length	(ft):	130

Sludge Handling

Type of digestion: aerobic
Number of digesters: 2
Volume #1 (gal): 47,100
Volume #2 (gal): 104,700

3.12 Pocatello, Idaho Wastewater Treatment Plant

Data Summary

Biological Process - Conventional Activated Sludge
Design Flow (mgd) - 12.0
Actual Flow (mgd) - 5.98
Predicted Effluent Quality Before Calibration (BOD/TSS mg/l) - 5/5
Actual Effluent Quality (BOD/TSS, mg/l) - 14/9
Predicted Effluent Quality After Calibration (BOD/TSS, mg/l) - 9/12

Background

The Pocatello treatment plant has in recent years, experienced relatively serious operating problems. However, recent process changes have improved the performance of the plant considerably. Effluent quality is generally good and operation of the plant is relatively stable.

Diagnostic Evaluation Results

General. One visit was made to the Pocatello treatment plant on 18 September, 1981 to evaluate operating conditions. During the visit the plant was operating well, and all equipment in operation appeared to be in good condition. Two aeration basins and one primary clarifier had been taken off line to reduce operating costs.

Process Limitations. The oxygen transfer capacity of the aeration system was marginal and limited the maximum MLSS concentration to about 1700 mg/l even though several aerators had been relocated from the off-line reactors to those left in operation. Also, the characteristicts of the secondary clarifiers were such that the top of the sludge blanket could not rise closer than 8-9 feet from the water surface before solids loss began to occur.

Operational Deficiencies. There were no operational deficiencies identified in the evaluation.

Model Accuracy. The effluent quality predictions of both the calibrated and uncalibrated models were relatively close to the actual

performance of the plant. The predictions of the calibrated model were slightly closer. The model was calibrated by allowing a maximum mixed liquor concentration of 1700 mg/l, a minimum clear water depth in the secondary clarifiers of 8.5 feet, and simulating operation with one primary clarifier and two aeration basins off line. The calibrated model predicted that, in the current mode of operation and with the existing wastewater characteristics, the overall performance of the plant will become limited by the solids handling capability of the secondary clarifiers as flows reach 8-9 mgd to the extent that it will probably not be able to meet its discharge limit. If both of the existing process limitations were corrected, the model predicts that the plant should be able to meet is discharge limit at design flow.

Recommendations. No recommendations regarding process limitations or operational deficiencies were made as a result of this evaluation.

POCATELLO, IDAHO WASTEWATER TREATMENT PLANT
WASTEWATER CHARACTERIZATION AND PLANT CONFIGURATION DATA

WASTEWATER CHARACTERIZATION

Average Dry Weather Flow	mgd:	5.98
Peak Dry Weather Flow	mgd:	9.2
Design Flow	mgd:	12
Influent BOD	mg/l:	181
Influent TSS	mg/l:	182
Influent VSS	(%):	80
Temperature	°C:	17
TKN	mg/l:	42.8
Alkalinity	mg/l:	100*
pH	:	7.7
PO4-P	mg/l:	8.32

*No actual data available. Typical values used.

PLANT CONFIGURATION AND DIMENSIONS

Primary Clarification

Number of round clarifiers: 3
Dimensions, each:

Diameter	(ft):	80
Depth	(ft):	80
Weir length	(ft):	502

Aeration Basins

Number of rectangular basins: 4
Dimensions, each:

Length	(ft):	150
Width	(ft):	47.5
Depth	(ft):	13

Secondary Clarification

Number of round clarifiers: 2
Dimensions, each:

Diameter	(ft):	120
Depth	(ft):	10
Weir length	(ft):	703

Sludge Handling

Sludge thickening: yes
Type: DAF
Type of digestion: anaerobic
Number of primary digesters: 1
Volume (gal): 385,000
Number of secondary digesters: 1
Volume (gal): 385,000

3.13 Shelton, Washington Wastewater Treatment Plant

Data Summary

Biological Process - Extended Aeration Oxidation Ditch
Design Flow (mgd) - 7.5
Actual Flow (mgd) - 2.5
Predicted Effluent Quality Before Calibration (BOD/TSS, mg/l) - 5/5
Actual Effluent Quality (BOD/TSS, mg/l) - 2/8
Predicted Effluent Quality After Calibration* (BOD/TSS, mg/l) - 5/7

* See "Model Accuracy" sub-section

Background

The Shelton treatment plant has been very stable in operation and has consistently produced a high quality effluent since being put on line.

Diagnostic Evaluation Results

General. Two visits were made to the Shelton treatment plant on 1 September and 17 December, 1981. At the time of both visits, the plant was operating well, and all equipment appeared to be in good condition.

Process Limitations. There were no process limitations identified in the evaluation.

Operational Deficiencies. Heavy accumulations of rags were noticed on the floating aerators in the aerobic digesters during the first visit. The low dissolved oxygen levels in the digesters may have resulted from decreased aerator efficiency caused by this problem.

Model Accuracy. Preliminary modeling of the Shelton plant indicated that the existing organic load is extremely light relative to the plant's process capabilities. Observations made during the first visit confirmed this fact. Preliminary modeling also produced effluent quality predictions which were very close to actual plant performance. Calibration of the model was accomplished by setting the maximum MLSS concentration equal to 2100 mg/l. Effluent quality predicted by the calibrated model was almost identical to the uncalibrated model. Next, the calibrated

model was used to simulate the performance of the plant with one of the two oxidation ditches shut down. This simulation predicted that with only one reactor on line, the plant should be able to meet its discharge limit at flows considerably higher than the existing flow. With both reactors on line, the model predicted that the plant should be able to meet its discharge limit at design flow with the existing wastewater characteristics.

Recommendations. It was recommended that one of the oxidation ditches be shut down to reduce operating costs, provided that the plant could accommodate peak hydraulic loads in this configuration. It was also recommended that if the plant staff elected not to make this change, that consideration be given to shutting down the aerobic digestion system. Present data indicates that very little volatile solids reduction occurs in the digesters due to the long mean cell residence time in the biological system, and the cost savings would be significant.

SHELTON, WASHINGTON WASTEWATER TREATMENT PLANT
WASTEWATER CHARACTERIZATION AND PLANT CONFIGURATION DATA

WASTEWATER CHARACTERIZATION

Average Dry Weather Flow	mgd:	2.5
Peak Dry Weather Flow	mgd:	3
Design Flow	mgd:	7.5
Influent BOD	mg/l:	89
Influent TSS	mg/l:	113
Influent VSS	(%):	84
Temperature	°C:	13
TKN	mg/l:	30*
Alkalinity	mg/l:	100*
pH	:	6.8
PO4-P	mg/l:	8*

*No actual data available. Typical values used.

PLANT CONFIGURATION AND DIMENSIONS

Oxidation Ditches

Number of oxidation ditches: 2
Dimension, each:
Volume (gal): 1,100,000

Secondary Clarification

Number of round clarifiers: 2
Dimensions, each:
Diameter (ft): 75
Depth (ft): 11
Weir length (ft): 236

Sludge Handling

Type of digestion: aerobic
Number of digesters: 2
Volume, #1 (gal): 58,500
Volume, #2 (gal): 58,500

3.14 Sultan, Washington Wastewater Treatment Plant

Data Summary

Biological Process - Extended Aeration Oxidation Ditch
Design Flow (mgd) - 0.20
Actual Flow (mgd) - 0.065
Predicted Effluent Quality Before Calibration (BOD/TSS, mg/l) - 5/5
Actual Effluent Quality (BOD/TSS, mg/l) - 30/30
Predicted Effluent Quality After Calibration (BOD/TSS, mg/l) - 5/5

Background

The Sultan treatment plant accepts wastewater from a small town with no significant industrial component. There are, however, five restaurants connected to the plant and high grease loadings are a continuing problem. There is an RV dump station connected directly to the plant, and the organic load and toxic materials contributed by this source are unknown. The plant also experiences extremely high inflow during wet weather which sometimes requires complete plant shutdowns to prevent total solids washout.

The plant has reported several effluent quality violations, and overall performance of the plant has been marginal in recent years.

Diagnostic Evaluation Results

General. Two visits were made to the Sultan treatment plant on 1 September and 18 December, 1981. During the first visit, the plant was not performing well. Effluent quality was poor and a considerable amount of grease had accumulated in the chlorine contact tank. Also, a grease dump was observed which caused the influent wastewater to turn milky white and had a distinct odor of fried foods. Finally, a sudden and relatively severe rainfall occurred which increased plant flow from less than 0.15 mgd to over 1.5 mgd in less than 30 minutes. This resulted in temporary overflow at the headworks, completely washed out the secondary clarifier, and required shutdown of the aeration brushes to allow solids to settle in the oxidation ditch and minimize their loss.

During the second visit, effluent quality had improved considerably, with reported BOD and TSS concentrations of 10 to 15 mg/l.

Process Limitations. The operators reported that the oxygen transfer capacity of the aeration system was marginal in summer months, and limited maximum MLSS concentrations to about 1700 mg/l, although higher concentrations could be maintained in winter months. Comparison of the calibrated and uncalibrated models indicated that there would be virtually no improvement in effluent quality if higher MLSS concentrations could be maintained at the existing flow, and also at much higher flows. Therefore, this is not truly a process limitation.

Return activated sludge and influent wastewater enters the ditch at one edge and mixing is very poor, resulting in a solids gradient across a significant portion of the ditch.

Operational Deficiencies. The Sultan plant is understaffed, which results in laboratory and process control work being given a low priority. The number of analyses which can be run is insufficient to allow proper process control. Moreover, inadequate training in process control theory and practice had been provided for the plant staff.

Model Accuracy. Both the calibrated and uncalibrated models indicated that the plant could produce a much better effluent than it had been prior to and during the first visit. Calibration of the model was accomplished by allowing a maximum MLSS concentration of 1700 mg/l. Effluent quality observed during the second visit was much closer to the model's predictions. The impact of RV dumps reaching the plant could not be assessed. The calibrated model indicated that the plant should be able to meet its discharge limit at design flow with the existing wastewater characteristics.

Recommendations. It was recommended that piping changes be made to improve mixing of influent wastewater and return activated sludge. It was also recommended that steps be taken to eliminate RV holding tank and restaurant grease dumps from entering the treatment system. Finally, it was recommended that additional staff time be devoted to laboratory and process control work at the plant.

SULTAN, WASHINGTON WASTEWATER TREATMENT PLANT
WASTEWATER CHARACTERIZATION AND PLANT CONFIGURATION DATA

WASTEWATER CHARACTERIZATION

Average Dry Weather Flow	mgd:	.065
Peak Dry Weather Flow	mgd:	.09
Design Flow	mgd:	.2
Influent BOD	mg/l:	250
Influent TSS	mg/l:	250
Influent VSS	(%):	80*
Temperature	°C:	15
TKN	mg/l:	30*
Alkalinity	mg/l:	100*
pH	:	7.1
PO4-P	mg/l:	8*

*No actual data available. Typical values used.

PLANT CONFIGURATION AND DIMENSIONS

Oxidation Ditches

Number of oxidation ditches: 1
Volume (gal): 180,000

Secondary Clarification

Number of round clarifiers: 1
Dimensions:

Diameter:	(ft):	25
Depth	(ft):	12
Weir length	(ft):	80

3.15 Toppenish, Washington Wastewater Treatment Plant

Data Summary

Biological Process - Rotating Biological Contactors
Design Flow (mgd) - 1.35
Actual Flow (mgd) - 0.879
Predicted Effluent Quality (BOD/TSS, mg/l) - 7/8
Actual Effluent Quality (BOD/TSS, mg/l) - 6/5

Background

The Toppenish treatment plant uses Rotating Biological Contactors to treat wastewater from a primarily residential area. During the peak infiltration months, flows often exceed the design hydraulic capacity of the plant. Nevertheless, the plant consistently produces a good effluent.

Diagnostic Evaluation Results

General. One visit was made to the Toppenish treatment plant on 3 September, 1981 to evaluate operating conditions. At the time of the visit, the plant was operating well and all equipment appeared to be in good condition.

Process Limitations. There were no process limitations identified in the evaluation.

Operational Deficiencies. There were no operational deficiencies identified in the evaluation.

Model Accuracy. The uncalibrated model produced effluent quality predictions that matched the actual performance of the plant almost exactly. Operating conditions at the plant did not indicate the need to prepare a calibrated model.

Recommendations. There were no recommendations made as a result of this evaluation.

TOPPENISH, WASHINGTON WASTEWATER TREATMENT PLANT
WASTEWATER CHARACTERIZATION AND PLANT CONFIGURATION DATA

WASTEWATER CHARACTERIZATION

Average Dry Weather Flow	mgd:	.879
Peak Dry Weather Flow	mgd:	1.114
Design Flow	mgd:	1.35
Influent BOD	mg/l:	135
Influent TSS	mg/l:	164
Influent VSS	(%):	80*
Temperature	°C:	15
TKN	mg/l:	30*
Alkalinity	mg/l:	100*
pH	:	7.2
PO4-P	mg/l:	8*

*No actual data available. Typical values used.

PLANT CONFIGURATION AND DIMENSIONS

Primary Clarification

Number of round clarifiers: 1
Dimensions:
- Diameter (ft): 80
- Depth (ft): 8
- Weir length (ft): 251

Rotating Biological Contactors

Type: mechanical drive
Number of process trains: 3
Number of shafts per train: 2
Shaft #1 surface area (ft2): 96,000
Shaft #2 surface area (ft2): 96,000

Secondary Clarification

Number of round clarifiers: 1
Dimensions:
- Diameter (ft): 65
- Depth (ft): 10
- Weir length (ft): 204

Sludge Handling

Type of digestion: anaerobic
Number of primary digesters: 1
Volume (gal): 146,700
Number of secondary digesters: 1
Volume (gal): 132,300

3.16 West Boise, Idaho Wastewater Treatment Plant

Data Summary

Biological Process - Extended Aeration
Design Flow (mgd) - 5.0
Actual Flow (mgd) - 4.42
Predicted Effluent Quality Before Calibration (BOD/TSS, mg/l) - 5/5
Actual Effluent Quality (BOD/TSS, mg/l) - 2/2
Predicted Effluent Quality After Calibration* (BOD/TSS, mg/l) - 5/5

* See "Model Accuracy" sub-section

Background

The West Boise treatment plant uses the extended aeration process to treat rather weak domestic wastewater. Wet weather flows exceed the plant's design capacity. Nevertheless, the plant consistently produces a good effluent.

Diagnostic Evaluation Results

General. One visit was made to the West Boise treatment plant on 16 September, 1981 to evaluate operating conditions. At the time of the visit, one of the two aeration basins had been shut down to reduce operating costs. The plant was operating well and all equipment appeared to be in good condition.

Process Limitations. There were no process limitations identified in the evaluation.

Operational Deficiencies. There were no operational deficiencies identified in the evaluation.

Model Accuracy. Both the calibrated and uncalibrated models produced effluent quality predictions that matched the actual performance of the plant almost exactly. The model was calibrated by simulating only one aeration basin and allowing a maximum MLSS concentration of 2600 mg/l. The calibrated model also indicated that under existing conditions, a mean cell residence time of well over 30 days could be maintained in the biological system. This usually elminates the need

for sludge digestion prior to disposal. Plant data indicated that very little volatile solids reduction was occurring in the aerobic digester at the present time.

The calibrated model predicted that the plant would be able to meet its discharge limit at flows considerably higher than the design flow with the existing wastewater characteristics.

Recommendations. It was recommended that consideration be given to shutting down the aerobic digester system in order to reduce operating costs.

WEST BOISE, IDAHO WASTEWATER TREATMENT PLANT
WASTEWATER CHARACTERIZATION AND PLANT CONFIGURATION DATA

WASTEWATER CHARACTERIZATION

Average Dry Weather Flow	mgd:	4.42
Peak Dry Weather Flow	mgd:	7.73
Design Flow	mgd:	5
Influent BOD	mg/l:	75
Influent TSS	mg/l:	121
Influent VSS	(%):	80*
Temperature	°C:	15
TKN	mg/l:	30*
Alkalinity	mg/l:	100*
pH	:	6.6
PO4-P	mg/l:	8*

*No actual data available. Typical values used.

PLANT CONFIGURATION AND DIMENSIONS

Aeration Basin

Number of rectangular aeration basins: 2
Dimensions, each:

Length	(ft):	180
Width	(ft):	180
Depth	(ft):	14

Secondary Clarifiers

Number of round clarifiers: 2
Dimensions:

Diameter	(ft):	100
Depth	(ft):	12
Weir length	(ft):	314

Sludge Handling

Type of digestion: aerobic
Number of digesters: 1
Volume (gal): 500,000

CHAPTER 4

PROCESS ANALYSES

General

In each of the ten treatment plant process analyses conducted, the plant was first modeled under the average expected operating conditions. Several of the plants analyzed had allowances for operation at very low temperatures. In cases where this information was available, plants were also simulated under the lowest temperature conditions anticipated. The results of the process analyses are summarized in Table 2.2.

The results fell into three general categories:

1) Plants in which no process limitations were identified and which should be able to meet their discharge limits at design flow with the expected wastewater characteristics. These plants are:

   Gooding, Idaho
   Grace, Idaho
   Hansen, Idaho
   Orofino, Idaho
   Pullman, Washington
   Sequim, Washington
   St. Maries, Idaho

Specific details of the process analysis results from these plants will not be presented in this report.

2) Plants whose ability to meet discharge limits at design flow with the expected wastewater characteristics appeared to be marginal. Only one plant -- Coeur D'Alene, Idaho -- fell into this category. This expansion is planned as an interim upgrade only. From a cost-effectiveness standpoint, this capacity upgrade seems well planned. As the facilities to be added to this plant are not intended to be permanent, specific details of the process analysis results will not be presented in this report.

3) Plants in which specific process limitations were identified which would probably prevent the plants from meeting their discharge requirements at design flow with the expected wastewater characteristics. Two plants fell into this category. These plants are:

Battle Ground, Washington

Sumner, Washington

Details of these process analyses are discussed below.

3.2 Battle Ground Washington

Data Summary

Biological process - Rotating Biological Contactors

Design Flow (mgd) - 0.77

Anticipated Effluent Quality Requirements (BOD/TSS, mg/1) - 10/10

Predicted Effluent Quality at Design Flow (BOD/TSS, mg/1) - 30/31

Process Limitations Identified

The treatment capacity of the rotating biological contactors was identified as the only significant process limitation. However, the predicted detention time and volatile solids reduction in the aerobic digester appeared also to be rather low.

Regarding the treatment capacity limitation in the rotating biological contactors, data from the Monroe and Toppenish treatment plants, which were evaluated on-site in this project, as well as data from several plants evaluated in other studies are presented for comparison in Table 4.1.

TABLE 4.1

COMPARISON OF RBC LOADING AND PLANT PERFORMANCE DATA

Treatment Plant Name	Total BOD Loading on Stage #1 (lb BOD/1000 ft^2)	Total BOD Loading on System (lb BOD/1000 ft^2)	Predicted Effluent Quality (BOD/TSS, mg/l)	Actual Effluent Quality (BOD/TSS, mg/l)
Toppenish, WA.	1.00	0.50	8/7	6/5
Battle Ground, WA.	3.88	1.06	30/31	---
Monroe, WA.	4.03	2.01	57/60	36/10
Enumclaw, WA.*	6.96	1.16	21/22	20/19
Ft. Knox, KY.*	3.42	0.46	11/11	12/14
Mobridge, SD.*	2.58	1.40	27/29	29/22
Pierre, SD.*	3.80	0.83	20/24	31/27
Wapato, WA.*	2.13	0.53	15/14	16/8

*Plants evaluated in other studies--data are presented for comparison.

Response to Analysis

The results of the process analysis were presented to individuals in EPA Region X and the State of Washington, who forwarded this information to the engineering firm preparing the design. A meeting was subsequently scheduled to allow representatives of the firm to review the results of the analysis. However, representatives of the firm were unable to attend this meeting.

3.3 Sumner, Washington

Data Summary

Biological Process - Extended Aeration
Design Flow (mgd) - 2.6
Anticipated Effluent Quality Requirements (BOD/TSS, mg/l) - 30/30
Predicted Effluent Quality (BOD/TSS, mg/l) - 63/98

Process Limitations Identified

The Sumner treatment plant design which was analyzed is an expansion of an existing facility that is currently operating in violation of its discharge permit. The existing plant has two circular secondary clarifiers with a side water depth of eight feet. The expansion would add, among other facilities, a new circular secondary clarifier with the same diameter as the existing units but with a side water depth of 12 feet. The process analysis indicated that the depth of the existing clarifiers would limit the overall performance of the plant. Further evaluation indicated that if the depth of the existing clarifiers was increased to 12 feet as part of the expansion, this limitation would be removed and the plant would be able to meet its discharge limit at design flow with the expected wastewater characteristics.

Response to Analysis

The results of the process analysis were presented to individuals in EPA Region X and the State of Washington, who forwarded this information to the engineering firm preparing the design. Representatives of the engineering firm subsequently met with individuals from EPA Region X, the State of Washington and ES_2 to discuss the evaluation. In a very

constructive discussion, it was decided that the issues identified in the process analysis were significant and should be considered carefully in the design. It was also decided that it would be appropriate to evaluate the existing plant to verify the validity of the model's predictions.

The Sumner plant was visited, data was obtained, and the plant was modelled. A comparison of predicted vs. actual plant performance in January, 1982 is shown below:

Predicted Effluent Quality (BOD/TSS, mg/l) - 52/94
Actual Effluent Quality (BOD/TSS, mg/l) - 60/61
Process Limitations Identified - Depth of Secondary Clarifier

These results, which closely matched the actual performance of the existing plant, add considerable validity to the model's prediction that the expanded plant would experience the same process limitation that was affecting the existing plant.

APPENDIX A

CONVENTIONAL ACTIVATED SLUDGE PROGRAM OUTPUT

IDEALIZED MATHEMATICAL MODEL OF GIG HARBOR, WASHINGTON CONVENTIONAL ACTIVATED SLUDGE WITHOUT PRIMARY CLARIFIERS WASTEWATER TREATMENT SYSTEM

Prepared by ES Environmental Services, by contract with Boise State University, Boise, Idaho. Through a grant from the Environmental Protection Agency, Region X, Seattle Washington.

CALIBRATED MODEL

DATE:
TIME: :

WASTEWATER CHARACTERIZATION

AVERAGE DRY WEATHER FLOW	MGD: .235
PEAK DRY WEATHER FLOW	MGD: .25
DESIGN FLOW	MGD: .45
INFLUENT BOD	MG/L: 312
INFLUENT TSS	MG/L: 183
INFLUENT VSS	(%): 92
TEMPERATURE	°C: 15
TKN	MG/L: 30 *
ALKALINITY	MG/L: 100 *
PH	: 7.4
PO4-P	MG/L: 8 *

*
DEFAULT VALUE USED

REACTION

NUMBER OF RECTANGULAR REACTORS: 2

DIMENSIONS		EACH
LENGTH	(FT):	18
WIDTH	(FT):	18
DEPTH	(FT):	16

DATE:
TIME: :

SECONDARY CLARIFICATION

NUMBER OF ROUND CLARIFIERS: 2

DIMENSIONS	EACH	TOTAL
DIAMETER (FT):	23	
DEPTH (FT):	11	
WEIR LTH (FT):	72	144
SFC AREA (FT2):	415	830

SLUDGE HANDLING

TYPE OF DIGESTION: AEROBIC

NUMBER OF DIGESTERS : 1

VOLUME OF #1 (GAL): 80784

GIG HARBOR, WASHINGTON

DATE:
TIME: :
BOD: 312
TSS: 183
TEMP 15

BIOLOGICAL REACTOR PERFORMANCE, PAGE 1

FLOW MGD	MAX MLSS	MLVSS %	F/M	MCRT DAYS	SVI	RAS MGD	RAS MG/L	WAS LBS/DAY
.176	3220	90	.283	9	104	.089	9559	216
.198	3208	90	.318	8	123	.129	8076	251
.219	3198	90	.353	7	140	.179	7098	287
.241	2069	91	.591	3	215	.189	4646	359
.262	1956	92	.680	3	231	.218	4325	402
.284	1843	92	.779	2	244	.228	4082	446
305	1731	92	.890	2	256	.238	3892	491
.327	1730	92	.953	2	262	.268	3810	531
.348	1619	92	1.08	1	271	.268	3677	577
.370	1618	92	1.15	1	275	.298	3623	618
.391	1617	92	1.21	1	279	.318	3577	658
.413	1508	92	1.37	1	286	.308	3488	705
.434	1507	92	1.44	1	289	.338	3456	746
.456	1507	92	1.51	1	291	.358	3427	786
.477	1506	92	1.59	1	293	.378	3401	827
.499	1506	92	1.66	1	295	.398	3378	869
.520	1505	93	1.73	1	297	.417	3357	910
.542	1505	93	1.80	1	299	.437	3338	951
.563	1504	93	1.87	0	301	.467	3321	992
.585	1396	93	2.09	0	305	.427	3275	1039

GIG HARBOR, WASHINGTON

DATE:
TIME: :
BOD: 312
TSS: 183
TEMP 15

BIOLOGICAL REACTOR PERFORMANCE, PAGE 2

FLOW MGD	DET HRS	TIME DAYS	LOAD LB BOD/1000 FT3	OUR MG/L /HR	O2 ROD. LBS/DAY
.17	10.5	.44	44.2	27.5	427.6
.19	9.41	.39	49.6	30.0	466.2
.21	8.48	.35	55.0	32.3	502.5
.24	7.73	.32	60.4	29.9	465.0
.26	7.09	.29	65.8	30.6	476.1
.28	6.55	.27	71.2	30.9	480.5
.30	6.09	.25	76.6	30.7	477.2
.32	5.69	.23	82.0	31.2	485.8
.34	5.34	.22	87.4	30.1	467.4
.37	5.03	.21	92.8	30.0	466.5
.39	4.75	.19	98.2	29.7	461.8
.41	4.50	.18	103.	26.8	416.5
.43	4.28	.17	109.	25.7	399.7
.45	4.08	.17	114.	24.3	378.2
.47	3.89	.16	119.	22.6	351.9
.49	3.73	.15	125.	20.6	320.5
.52	3.57	.14	130.	18.2	283.8
.54	3.43	.14	136.	15.5	241.5
.56	3.30	.13	141.	12.4	193.5
.58	3.18	.13	146.	3.25	50.49

GIG HARBOR, WASHINGTON

DATE:
TIME: :
BOD: 312
TSS: 183
TEMP 15

FINAL CLARIFIER PERFORMANCE AND EFFLUENT CHARACTORISTICS

FLOW MGD	DET. TIME HRS.	DOB FT	EFF BOD MG/L	EFF TSS MG/L	EFF NH3 MG/L	EFF NO3 MG/L	EFF PO4-P MG/L
.176	9.31	7.3	10	15	21.9	<1.0	4
.198	8.30	6.6	12	17	21.6	<1.0	4
.219	7.48	6.0	15	20	21.4	<1.0	4
.241	6.81	6.1	31	39	20.2	<1.0	4
.262	6.26	6.0	38	48	19.9	<1.0	4
.284	5.78	6.0	45	57	19.6	<1.0	3
.305	5.37	6.1	53	68	19.4	<1.0	3
.327	5.02	6.0	58	75	19.3	<1.0	3
.348	4.71	6.2	68	89	19.1	<1.0	3
.370	4.44	6.1	74	97	19.0	<1.0	3
.391	4.19	6.0	80	106	18.9	<1.0	3
.413	3.97	6.2	92	124	18.7	<1.0	3
.434	3.78	6.2	99	134	18.7	<1.0	3
.456	3.60	6.2	106	144	18.6	<1.0	3
.477	3.44	6.1	113	155	18.6	<1.0	3
.499	3.29	6.1	120	166	18.5	<1.0	3
.520	3.15	6.1	128	177	18.5	<1.0	3
.542	3.03	6.0	136	189	18.4	<1.0	3
.563	2.91	6.0	144	201	18.4	<1.0	3
.585	2.80	6.3	165	232	18.3	<1.0	3

GIG HARBOR, WASHINGTON

DATE:
TIME: :
BOD: 312
TSS: 183
TEMP 15

SECONDARY SYSTEM PERFORMANCE

FLOW MGD	CLARIFIER LOAD SFC GPSFD	CLARIFIER LOAD WEIR GPLFD	SEC. SLUDGE PROD LBS TSS	SEC. SLUDGE PROD LBS VSS	TOTAL SLUDGE PROD LBS TSS	TOTAL SLUDGE PROD LBS VSS	% SOL	GPD
.180	212	1223	216	195	216	195	2.00	1297
.200	241	1388	255	231	255	231	2.00	1530
.220	265	1527	289	262	289	262	2.00	1730
.240	289	1666	358	328	358	328	2.00	2144
.260	313	1805	398	366	398	366	2.00	2387
.280	337	1944	439	405	439	405	2.00	2634
310	373	2152	500	462	500	462	2.00	2997
.330	397	2291	542	502	542	502	2.00	3252
.350	421	2430	580	537	580	537	2.00	3478
.370	445	2569	618	573	618	573	2.00	3704
.390	469	2708	656	608	656	608	2.00	3931
.410	493	2847	699	649	699	649	2.00	4191
.430	517	2986	737	685	737	685	2.00	4419
.460	554	3194	794	738	794	738	2.00	4762
.480	578	3333	832	774	832	774	2.00	4990
.500	602	3472	871	809	871	809	2.00	5219
.520	626	3611	909	845	909	845	2.00	5448
.540	650	3750	947	881	947	881	2.00	5677
.560	674	3888	985	917	985	917	2.00	5906
590	710	4097	1049	977	1049	977	2.00	6288

GIG HARBOR, WASHINGTON

DATE:
TIME: :

DIGESTER PERFORMANCE
AEROBIC

BOD: 312
TSS: 183
TEMP 15
DIGESTER VOLUME (GAL): 80784

PLANT FLOW MGD	TOTAL SLUDGE FLOW GPD	VSS LOADING LB/FT3/ DAY	MCRT DAYS	% VSS RED.	ALK. MG/L	GAS PRO. FT3/ DAY	% SOL DIG. SLUDGE
.18	1296	.02	62.3	68.25	NA	NA	.78
.20	1529	.02	52.8	64.56	NA	NA	.84
.22	1730	.02	46.7	61.69	NA	NA	.89
.24	2144	.03	37.7	56.52	NA	NA	.97
.26	2387	.03	33.8	53.86	NA	NA	1.01
.28	2634	.04	30.7	51.41	NA	NA	1.06
.31	2997	.04	27.0	48.18	NA	NA	1.11
.33	3252	.05	24.8	46.15	NA	NA	1.15
.35	3477	.05	23.2	44.49	NA	NA	1.18
.37	3703	.05	21.8	42.94	NA	NA	1.21
.39	3930	.06	20.6	41.49	NA	NA	1.24
.41	4191	.06	19.3	39.94	NA	NA	1.26
.43	4419	.06	18.3	38.67	NA	NA	1.29
.46	4761	.07	17.0	36.92	NA	NA	1.32
.48	4990	.07	16.2	35.83	NA	NA	1.34
.50	5218	.07	15.5	34.81	NA	NA	1.36
.52	5447	.08	14.8	33.84	NA	NA	1.37
.54	5677	.08	14.2	32.93	NA	NA	1.39
.56	5906	.08	13.7	32.06	NA	NA	1.41
.59	6288	.09	12.8	30.71	NA	NA	1.43

A- NOT APPLICABLE FOR AEROBIC DIGESTION

APPENDIX B

EXTENDED AERATION PROGRAM OUTPUT

IDEALIZED MATHEMATICAL MODEL OF KETCHUM, IDAHO EXTENDED AERATION WITHOUT PRIMARY CLARIFICATION WASTEWATER TREATMENT SYSTEM

Prepared by ES Environmental Services,
by contract with Boise State
University, Boise, Idaho. Through a grant from the
Environmental Protection Agency, Region X,
Seattle Washington.

CALIBRATED MODEL

DATE:
TIME: :

WASTEWATER CHARACTERIZATION

AVERAGE DRY WEATHER FLOW	MGD: .72
PEAK DRY WEATHER FLOW	MGD: 1.27
DESIGN FLOW	MGD: 1.5
INFLUENT BOD	MG/L: 132
INFLUENT TSS	MG/L: 93
INFLUENT VSS	(%): 80 *
TEMPERATURE	°C: 15
TKN	MG/L: 30 *
ALKALINITY	MG/L: 100 *
PH	: 7 *
PO4-P	MG/L: 5.2

*
DEFAULT VALUE USED

PLANT CONFIGURATION AND DIMENSIONS

DESIGN AVERAGE DAILY FLOW (MGD) : 2.25
DESIGN PEAK WET WEATHER FLOW (MGD): 4.5

REACTION

NUMBER OF RECTANGULAR REACTORS: 2

DIMENSIONS		EACH
LENGTH	(FT):	100
WIDTH	(FT):	50
DEPTH	(FT):	12.5

DATE:
TIME: :

SECONDARY CLARIFICATION

NUMBER OF ROUND CLARIFIERS: 2

DIMENSIONS	#1	#2	TOTAL
DIAMETER (FT):	45	55	
DEPTH (FT):	10.25	12.75	
WEIR LTH (FT):	141	220	361
SURFACE AREA :	1590	2375	3965

SLUDGE HANDLING

TYPE OF DIGESTION: AEROBIC

NUMBER OF DIGESTERS : 1

VOLUME OF #1 (GAL): 30000

KETCHUM, IDAHO

DATE:
TIME: :
BOD: 132
TSS: 93
TEMP 15

BIOLOGICAL REACTOR PERFORMANCE

FLOW MGD	MAX MLSS	MLVSS %	F/M	MCRT DAYS	SVI	RAS MGD	RAS MG/L	WAS LBS/DAY
.540	4128	55	.040	170	100	.378	10000	189
.610	4030	57	.040	141	100	.407	10000	222
.690	3946	58	.050	120	100	.447	10000	256
.760	4072	58	.050	110	100	.517	10000	288
.840	4003	59	.060	96	100	.557	10000	324
.910	4136	60	.060	90	100	.636	10000	357
990	4078	61	.060	80	100	.676	10000	395
1.06	4026	62	.070	72	100	.706	10000	434
1.13	3978	62	.070	65	100	.746	10000	473
1.21	4120	63	.080	63	100	.845	10000	508
1.28	4078	63	.080	57	100	.875	10000	549
1.36	4040	64	.090	53	100	.915	10000	590
1.43	4004	64	.090	49	100	.955	10000	633
1.50	3971	65	.090	45	100	.985	10000	676
1.58	4117	65	.100	45	100	1.10	10000	712
1.65	4087	66	.100	42	100	1.13	10000	756
1.73	4059	66	.100	39	100	1.17	10000	800
1.80	4033	66	.110	37	100	1.21	10000	846
1.88	4008	67	.110	35	100	1.24	10000	892
1.95	3985	67	.120	33	100	1.28	10000	938

KETCHUM, IDAHO

DATE:
TIME: :
BOD: 132
TSS: 93
TEMP 15

FINAL CLARIFIER PERFORMANCE AND EFFLUENT CHARACTERISTICS

FLOW MGD	OUR MG/L /HR	DOB FT	EFF BOD	EFF TSS MG/L	EFF NH3 MG/L	EFF NO3 MG/L	EFF PO4-P MG/L
.540	3	6.0	<5	<5	<1.0	27.7	3
.610	4	6.1	<5	<5	<1.0	27.6	3
.690	4	6.2	<5	<5	<1.0	27.5	3
.760	5	6.1	<5	<5	<1.0	27.5	3
.840	5	6.1	<5	<5	<1.0	27.4	3
.910	6	6.0	<5	<5	<1.0	27.4	3
.990	6	6.1	<5	<5	<1.0	27.4	3
1.06	7	6.1	<5	<5	<1.0	27.3	3
1.13	7	6.2	<5	<5	<1.0	27.2	3
1.21	8	6.0	<5	<5	<1.0	27.2	3
1.28	8	6.1	<5	<5	<1.0	27.2	3
1.36	9	6.1	<5	<5	<1.0	27.1	3
1.43	9	6.1	<5	<5	<1.0	27.1	3
1.50	10	6.2	<5	<5	<1.0	27.0	3
1.58	10	6.0	<5	<5	<1.0	27.0	3
1.65	11	6.1	<5	<5	<1.0	27.0	3
1.73	11	6.1	<5	<5	<1.0	26.9	3
1.80	11	6.1	<5	<5	<1.0	26.9	3
1.88	12	6.1	<5	<5	<1.0	26.9	3
1.95	12	6.2	<5	5	<1.0	26.8	3

KETCHUM, IDAHO

DATE:
TIME: :
BOD: 132
TSS: 93
TEMP 15

SECONDARY SYSTEM PERFORMANCE

FLOW	CLARIFIER LOAD		SEC. SLUDGE PROD		TOTAL SLUDGE PROD			
MGD	SFC	WEIR	LBS TSS	LBS VSS	LBS TSS	LBS VSS	% SOL	GPD
	GPSFD	GPLFD						
.540	136	1495	189	105	189	105	2.31	982
.610	154	1689	220	125	220	125	2.26	1168
.690	174	1911	257	150	257	150	2.21	1395
.760	192	2105	287	169	287	169	2.17	1582
.840	212	2326	326	195	326	195	2.13	1834
.910	229	2520	357	216	357	216	2.10	2034
990	250	2742	397	244	397	244	2.06	2309
1.06	267	2936	434	269	434	269	2.03	2561
1.13	285	3130	471	296	471	296	2.00	2824
1.21	305	3351	509	321	509	321	1.98	3086
1.28	323	3545	548	349	548	349	1.95	3366
1.36	343	3767	592	381	592	381	1.92	3697
1.43	361	3961	632	411	632	411	1.90	3998
1.50	378	4155	673	441	673	441	1.87	4307
1.58	398	4376	712	467	712	467	1.86	4596
1.65	416	4570	754	498	754	498	1.84	4919
1.73	436	4792	802	534	802	534	1.81	5299
1.80	454	4986	845	565	845	565	1.80	5640
1.88	474	5207	894	603	894	603	1.78	6039
1.95	492	5401	938	636	938	636	1.76	6397

KETCHUM, IDAHO

DATE:
TIME: :

DIGESTER PERFORMANCE
AEROBIC

BOD: 132
TSS: 93
TEMP 15
DIGESTER VOLUME (GAL): 30000

PLANT FLOW MGD	TOTAL SLUDGE FLOW GPD	VSS LOADING LB/FT3/ DAY	MCRT DAYS	% VSS RED.	ALK. MG/L	GAS PRO. FT3/ DAY	% SOL DIG. SLUDGE
.54	982	.03	30.5	4.296	NA	NA	2.25
.61	1167	.03	25.7	4.298	NA	NA	2.20
.69	1395	.04	21.5	4.295	NA	NA	2.15
.76	1581	.04	19.0	4.106	NA	NA	2.12
.84	1834	.05	16.4	4.095	NA	NA	2.07
.91	2033	.05	14.7	3.917	NA	NA	2.05
.99	2309	.06	13.0	3.903	NA	NA	2.01
1.06	2561	.07	11.7	3.890	NA	NA	1.98
1.13	2824	.07	10.6	3.875	NA	NA	1.95
1.21	3086	.08	9.70	3.708	NA	NA	1.93
1.28	3365	.09	8.90	3.694	NA	NA	1.90
1.36	3697	.10	8.10	3.676	NA	NA	1.87
1.43	3997	.10	7.50	3.661	NA	NA	1.85
1.50	4306	.11	7.00	3.646	NA	NA	1.83
1.58	4596	.12	6.50	3.494	NA	NA	1.81
1.65	4919	.12	6.10	3.479	NA	NA	1.79
1.73	5298	.13	5.70	3.462	NA	NA	1.77
1.80	5639	.14	5.30	3.448	NA	NA	1.75
1.88	6039	.15	5.00	3.432	NA	NA	1.73
1.95	6397	.16	4.70	3.418	NA	NA	1.71

A- NOT APPLICABLE FOR AEROBIC DIGESTION

APPENDIX C

EXTENDED AERATION OXIDATION DITCH PROGRAM OUTPUT

IDEALIZED MATHEMATICAL MODEL OF SHELTON, WASHINGTON EXTENDED AERATION OXIDATION DITCH WITHOUT PRIMARY CLARIFICATION WASTEWATER TREATMENT SYSTEM

Prepared by ES Environmental Services,
by contract with Boise State
University, Boise, Idaho. Through a grant from the
Environmental Protection Agency, Region X,
Seattle Washington.

CALIBRATED MODEL

DATE:
TIME: :

WASTEWATER CHARACTERIZATION

AVERAGE DRY WEATHER FLOW	MGD:	2.5
PEAK DRY WEATHER FLOW	MGD:	2.99
DESIGN FLOW	MGD:	7.5
INFLUENT BOD	MG/L:	89
INFLUENT TSS	MG/L:	113
INFLUENT VSS	(%):	84
TEMPERATURE	°C:	13
TKN	MG/L:	30 *
ALKALINITY	MG/L:	100 *
PH	:	6.8
PO4-P	MG/L:	8 *

*
DEFAULT VALUE USED

PLANT CONFIGURATION AND DIMENSIONS

DESIGN AVERAGE DAILY FLOW (MGD) : 7.5
DESIGN PEAK WET WEATHER FLOW (MGD): 10

OXIDATION

NUMBER OF OXIDATION DITCHES: 1

DIMENSIONS	EACH	TOTAL
VOLUME (GAL):	1100000	1100000

SHELTON, WASHINGTON

DATE:
TIME: :
BOD: 89
TSS: 113
TEMP 13

BIOLOGICAL OXIDATION PERFORMANCE

FLOW MGD	MAX MLSS	MLVSS %	F/M	MCRT DAYS	SVI	RAS MGD	RAS MG/L	WAS LBS/DAY
1.88	2070	62	.140	24	100	.487	10000	760
2.29	2007	64	.180	18	100	.567	10000	980
2.70	1960	66	.210	14	100	.656	10000	1211
3.12	2092	66	.220	13	100	.815	10000	1422
3.53	2060	67	.250	11	100	.915	10000	1663
3.95	2034	68	.280	9	102	1.03	9717	1910
4.36	2012	69	.310	8	119	1.37	8363	2162
4.78	1994	70	.340	7	134	1.74	7427	2418
5.19	1979	70	.370	6	148	2.13	6748	2676
5.61	1965	71	.400	6	160	2.56	6236	2938
6.02	1954	71	.430	5	171	3.01	5838	3203
6.43	2094	71	.430	5	170	3.57	5850	3421
6.85	2083	71	.450	5	180	4.09	5550	3688
7.26	2074	72	.480	4	188	4.64	5303	3956
7.68	2066	72	.510	4	196	5.20	5097	4225
8.09	2059	72	.540	4	203	5.79	4922	4496
8.51	2052	73	.560	3	209	6.38	4772	4769
8.92	2046	73	.590	3	215	6.99	4642	5042
9.34	2040	73	.620	3	220	7.61	4529	5317
9.75	1892	73	.690	3	233	7.66	4287	5653

SHELTON, WASHINGTON

DATE:
TIME: :
BOD: 89
TSS: 113
TEMP 13

FINAL CLARIFIER PERFORMANCE AND EFFLUENT CHARACTERISTICS

FLOW MGD	OUR MG/L /HR	DOB FT	EFF BOD	EFF TSS MG/L	EFF NH3 MG/L	EFF NO3 MG/L	EFF PO4-P MG/L
1.88	6	8.7	<5	<5	<1.0	27.3	5
2.29	7	8.8	<5	6	<1.0	27.2	5
2.70	8	8.8	<5	8	<1.0	27.0	5
3.12	10	8.7	5	10	<1.0	27.0	5
3.53	11	8.7	6	12	<1.0	26.9	5
3.95	12	8.7	8	15	26.8	<1.0	5
4.36	13	8.4	10	19	26.7	<1.0	5
4.78	14	8.0	13	23	26.7	<1.0	5
5.19	15	7.8	16	27	26.6	<1.0	5
5.61	16	7.5	19	32	26.5	<1.0	5
6.02	18	7.3	22	37	26.5	<1.0	5
6.43	19	7.1	23	40	26.5	<1.0	5
6.85	20	6.9	27	46	26.4	<1.0	5
7.26	21	6.7	31	53	26.4	<1.0	5
7.68	22	6.5	35	61	26.4	<1.0	5
8.09	23	6.4	40	69	26.3	<1.0	5
8.51	24	6.3	46	79	26.3	<1.0	5
8.92	25	6.2	51	89	26.3	<1.0	5
9.34	26	6.0	58	100	26.2	<1.0	5
9.75	27	6.1	71	123	26.2	<1.0	5

SHELTON, WASHINGTON

DATE:
TIME: :
BOD: 89
TSS: 113
TEMP 13

SECONDARY SYSTEM PERFORMANCE

FLOW MGD	CLARIFIER LOAD SFC GPSFD	CLARIFIER LOAD WEIR GPLFD	SEC. SLUDGE PROD LBS TSS	SEC. SLUDGE PROD LBS VSS	TOTAL SLUDGE PROD LBS TSS	TOTAL SLUDGE PROD LBS VSS	% SOL	GPD
1.88	212	3972	760	477	760	477	2.31	3940
2.29	259	4851	981	635	981	635	2.21	5329
2.70	306	5720	1209	802	1209	802	2.12	6835
3.12	353	6610	1423	952	1423	952	2.06	8268
3.53	400	7478	1662	1129	1662	1129	2.00	9962
3.95	447	8368	1912	1316	1912	1316	1.94	11796
4.36	493	9237	2161	1503	2161	1503	1.89	13674
4.78	541	10127	2420	1699	2420	1699	1.85	15678
5.19	587	10995	2676	1893	2676	1893	1.81	17707
5.61	635	11885	2941	2095	2941	2095	1.78	19853
6.02	681	12754	3203	2295	3203	2295	1.74	22009
6.43	728	13622	3419	2449	3419	2449	1.72	23764
6.85	775	14512	3688	2656	3688	2656	1.70	26058
7.26	822	15381	3954	2859	3954	2859	1.67	28347
7.68	869	16271	4227	3069	4227	3069	1.65	30739
8.09	916	17139	4495	3275	4495	3275	1.63	33117
8.51	963	18029	4771	3488	4771	3488	1.61	35594
8.92	1010	18898	5042	3697	5042	3697	1.59	38049
9.34	1057	19788	5320	3912	5320	3912	1.57	40601
9.75	1103	20656	5653	4183	5653	4183	1.55	43751

SHELTON, WASHINGTON

DATE:
TIME: :
BOD: 89
TSS: 113
TEMP 13

DIGESTER PERFORMANCE
AEROBIC

DIGESTER VOLUME (GAL): 1170000

PLANT FLOW MGD	TOTAL SLUDGE FLOW GPD	VSS LOADING LB/FT3/ DAY	MCRT DAYS	% VSS RED.	ALK. MG/L	GAS PRO. FT3/ DAY	% SOL DIG. SLUDGE
1.88	3939	1E-	297.	74.81	NA	NA	1.24
2.29	5328	1E-	219.	74.51	NA	NA	1.15
2.70	6834	.01	171.	74.20	NA	NA	1.08
3.12	8267	.01	141.	72.40	NA	NA	1.07
3.53	9962	.01	117.	72.08	NA	NA	1.03
3.95	11796	.01	99.2	71.76	NA	NA	.99
4.36	13674	.01	85.6	71.46	NA	NA	.96
4.78	15678	.01	74.6	71.16	NA	NA	.93
5.19	17707	.01	66.1	70.88	NA	NA	.91
5.61	19853	.01	58.9	70.61	NA	NA	.89
6.02	22009	.01	53.2	70.36	NA	NA	.87
6.43	23764	.02	49.2	68.65	NA	NA	.88
6.85	26058	.02	44.9	68.41	NA	NA	.86
7.26	28346	.02	41.3	68.19	NA	NA	.85
7.68	30738	.02	38.1	67.97	NA	NA	.84
8.09	33116	.02	35.3	67.76	NA	NA	.83
8.51	35593	.02	32.9	67.56	NA	NA	.82
8.92	38049	.02	30.7	67.37	NA	NA	.81
9.34	40601	.03	28.8	67.18	NA	NA	.80
9.75	43751	.03	26.7	68.52	NA	NA	.77

1A- NOT APPLICABLE FOR AEROBIC DIGESTION

APPENDIX D

ACTIVATED BIO-FILTER PROGRAM OUTPUT

IDEALIZED MATHEMATICAL MODEL OF MERIDIAN, IDAHO ACTIVATED BIOLOGICAL FILTER WASTEWATER TREATMENT SYSTEM

Prepared by ES Environmental Services,
by contract with Boise State
University, Boise, Idaho. Through a grant from the
Environmental Protection Agency, Region X,
Seattle Washington.

CALIBRATED MODEL

DATE:
TIME: :

WASTEWATER CHARACTERIZATION

AVERAGE DRY WEATHER FLOW	MGD: 2.04
PEAK DRY WEATHER FLOW	MGD: 2.5
DESIGN FLOW	MGD: 2.82
INFLUENT BOD	MG/L: 108
INFLUENT TSS	MG/L: 153
INFLUENT VSS	(%): 80 *
TEMPERATURE	°C: 15
TKN	MG/L: 35.5
ALKALINITY	MG/L: 100 *
PH	: 7.7
PO4-P	MG/L: 8 *

* DEFAULT VALUE USED

PLANT CONFIGURATION AND DIMENSIONS

DESIGN AVERAGE DAILY FLOW (MGD): 2.82
DESIGN PEAK WET WEATHER FLOW (MGD): 5.5

PRIMARY CLARIFICATION

NUMBER OF ROUND CLARIFIERS: 1

DIMENSIONS	EACH	TOTAL
DIAMETER (FT):	40	
DEPTH (FT):	8	
WEIR LTH (FT):	126	126
SFC AREA (FT2):	1256	1256

BIO TOWER

MEDIA TYPE: REDWOOD
CONSTANT RECIRCULATION
NUMBER OF BIO TOWERS: 1

DIMENSIONS	EACH
LENGTH (FT):	56
WIDTH (FT):	24
DEPTH (FT):	14
RECIR.RATE(GPM):	2500

DATE:
TIME: :

REACTION

NUMBER OF RECTANGULAR REACTORS: 1

DIMENSIONS		EACH
LENGTH	(FT):	64
WIDTH	(FT):	34
DEPTH	(FT):	14

SECONDARY CLARIFICATION

NUMBER OF RECTANGULAR CLARIFIERS: 2

DIMENSIONS		EACH	TOTAL
LENGTH	(FT):	96	
WIDTH	(FT):	24	
DEPTH	(FT):	8	
WEIR LTH	(FT):	80	160
SFC AREA	(FT2):	2304	4608

DATE:
TIME: :

SLUDGE HANDLING

SLUDGE THICKENING : YES
TYPE : DAF

TYPE OF DIGESTION: ANAEROBIC

NUMBER OF PRIMARY DIGESTERS: 1

	#1
VOLUME (GAL):	130000
DIGESTER HEATED	Y
DIGESTER MIXED	Y

NUMBER OF SECONDARY DIGESTERS: 1

VOLUME FOR DIGESTER #1 (GAL): 130000

MERIDIAN, IDAHO

DATE:
TIME: :
BOD: 108
TSS: 153
TEMP 15

PRIMARY SYSTEM LOADINGS

FLOW MGD	CLAR. LOADINGS SURFACE GPDSF	WEIR GDP/FT	DETN TIME HRS.
1.56	1241	12380	1.16
1.67	1329	13253	1.08
1.78	1416	14126	1.01
1.89	1504	15000	.95
2.00	1592	15873	.90
2.11	1679	16746	.86
2.23	1775	17698	.81
2.34	1862	18571	.77
2.45	1950	19444	.74
2.56	2037	20317	.70
2.67	2125	21190	.68
2.78	2212	22063	.65
2.89	2300	22936	.62
3.00	2387	23809	.60
3.11	2475	24682	.58
3.22	2562	25555	.56
3.33	2650	26428	.54
3.44	2737	27301	.52
3.56	2833	28253	.51
3.67	2920	29126	.49

MERIDIAN, IDAHO

DATE:
TIME: :
BOD: 108
TSS: 153
TEMP 15

PRIMARY SYSTEM PERFORMANCE

FLOW MGD	% REMOVAL BOD	TSS	P.C. EFF MG/L BOD	TSS	PRIMARY SLUDGE PROD. LBS TSS	LBS VSS	% SOL	GDF
1.56	31	39	75	94	773	619	7.62	1217
1.67	30	37	76	96	795	636	7.62	1251
1.78	29	36	77	98	815	652	7.62	1283
1.89	28	35	78	100	833	667	7.62	1312
2.00	27	33	79	102	851	681	7.62	1339
2.11	26	32	80	104	867	694	7.62	1365
2.23	26	31	80	105	884	707	7.62	1391
2.34	25	30	81	107	898	719	7.62	1414
2.45	25	29	81	108	912	730	7.62	1436
2.56	24	28	82	110	925	740	7.62	1456
2.67	24	28	83	111	938	750	7.62	1476
2.78	23	27	83	112	949	759	7.62	1495
2.89	23	26	83	113	961	769	7.62	1512
3.00	22	25	84	114	972	777	7.62	1530
3.11	22	25	84	115	982	786	7.62	1546
3.22	22	24	85	116	992	794	7.62	1562
3.33	21	24	85	117	1002	801	7.62	1577
3.44	21	23	85	118	1011	809	7.62	1592
3.56	21	22	86	119	1021	817	7.62	1607
3.67	21	22	86	119	1029	824	7.62	1621

MERIDIAN, IDAHO

DATE:
TIME: :
BOD: 108
TSS: 153
TEMP 15

SECONDARY SYSTEM LOADINGS

FLOW MGD	FILTER LOADING GPDSF	FILTER LOADING # BOD 1000FT3	RECIR. RATIO %	FILTER LOADINGS SURFACE GPMSF	FILTER LOADINGS FLOW GPM
1.56	1160	51	0	2.7	3583
1.67	1242	56	0	2.7	3659
1.78	1324	60	0	2.8	3736
1.89	1406	65	0	2.8	3812
2.00	1488	69	0	2.9	3888
2.11	1569	74	0	3.0	3965
2.23	1659	79	0	3.0	4048
2.34	1741	83	0	3.1	4124
2.45	1822	88	0	3.1	4201
2.56	1904	93	0	3.2	4277
2.67	1986	97	0	3.2	4354
2.78	2068	102	0	3.3	4430
2.89	2150	106	0	3.4	4506
3.00	2232	111	0	3.4	4583
3.11	2313	116	0	3.5	4659
3.22	2395	120	0	3.5	4735
3.33	2477	125	0	3.6	4812
3.44	2559	129	0	3.6	4888
3.56	2648	134	0	3.7	4972
3.67	2730	139	0	3.8	5048

MERIDIAN, IDAHO

DATE:
TIME: :
BOD: 108
TSS: 153
TEMP 15

BIOLOGICAL REACTOR PERFORMANCE

FLOW MGD	MAX MLSS	MLVSS %	SRV	MCRT DAYS	SVI	RAS MGD	RAS MG/L	WAS LBS/DAY
1.56	3672	57	.180	18	100	.905	10000	381
1.67	3727	57	.190	16	100	.985	10000	423
1.78	3684	58	.210	14	100	1.03	10000	469
1.89	3744	58	.220	13	100	1.12	10000	514
2.00	3708	59	.230	12	100	1.17	10000	562
2.11	3676	59	.250	11	100	1.22	10000	611
2.23	3741	60	.260	10	100	1.32	10000	658
2.34	3713	60	.280	9	100	1.38	9951	709
2.45	1754	65	.570	3	211	1.43	4731	860
2.56	1667	65	.630	3	223	1.50	4482	922
2.67	1581	66	.700	3	233	1.55	4276	985
2.78	1496	66	.770	2	243	1.59	4102	1049
2.89	1493	66	.810	2	248	1.69	4029	1107
3.00	1411	67	.890	2	256	1.69	3895	1172
3.11	1408	67	.930	2	260	1.79	3842	1231
3.22	1405	67	.970	2	263	1.89	3794	1290
3.33	1403	67	1.01	1	266	1.98	3750	1349
3.44	1323	68	1.10	1	273	1.94	3659	1417
3.56	1322	68	1.15	1	275	2.02	3626	1477
3.67	1320	68	1.19	1	278	2.11	3595	1538

MERIDIAN, IDAHO

DATE:
TIME: :
BOD: 108
TSS: 153
TEMP 15

FINAL CLARIFIER PERFORMANCE AND EFFLUENT CHARACTERISTICS

FLOW MGD	OUR MG/L /HR	DOB FT	EFF BOD MG/L	EFF TSS MG/L	EFF NH3 MG/L	EFF NO3 MG/L	EFF PO4-P MG/L
1.56	22	5.1	<5	7	<1.0	33.9	5
1.67	24	5.0	<5	7	<1.0	33.8	5
1.78	26	5.1	<5	8	<1.0	33.8	5
1.89	28	5.0	<5	9	<1.0	33.7	5
2.00	30	5.0	<5	10	<1.0	33.7	5
2.11	32	5.1	5	12	<1.0	33.6	5
2.23	34	5.0	6	12	<1.0	33.5	5
2.34	36	5.0	7	14	33.5	<1.0	5
2.45	38	5.0	22	36	33.2	<1.0	5
2.56	41	5.0	25	41	33.1	<1.0	5
2.67	43	5.0	29	47	33.1	<1.0	5
2.78	45	5.1	33	54	33.0	<1.0	5
2.89	47	5.0	35	58	33.0	<1.0	5
3.00	49	5.1	40	66	32.9	<1.0	5
3.11	52	5.1	43	71	32.9	<1.0	5
3.22	54	5.0	45	76	32.9	<1.0	5
3.33	56	5.0	48	81	32.8	<1.0	5
3.44	58	5.1	54	92	32.8	<1.0	5
3.56	61	5.1	57	98	32.8	<1.0	5
3.67	63	5.1	60	104	32.7	<1.0	5

MERIDIAN, IDAHO

DATE:
TIME: :
BOD: 108
TSS: 153
TEMP 15

SECONDARY SYSTEM PERFORMANCE

FLOW MGD	CLARIFIER LOAD SFC GPSFD	CLARIFIER LOAD WEIR GPLFD	SEC. SLUDGE PROD LBS TSS	SEC. SLUDGE PROD LBS VSS	TOTAL SLUDGE PROD LBS TSS	TOTAL SLUDGE PROD LBS VSS	% SOL	GPD
1.56	339	9750	381	218	1154	837	3.95	3502
1.67	362	10437	423	244	1218	880	3.85	3788
1.78	386	11125	469	274	1283	925	3.76	4093
1.89	410	11812	513	301	1346	968	3.68	4386
2.00	434	12500	560	332	1411	1013	3.60	4699
2.11	458	13187	609	364	1476	1058	3.53	5016
2.23	484	13937	660	397	1544	1104	3.46	5347
2.34	508	14625	710	430	1608	1149	3.40	5671
2.45	532	15312	861	565	1773	1294	3.22	6600
2.56	556	16000	923	609	1848	1349	3.17	6991
2.67	579	16687	986	655	1923	1405	3.12	7386
2.78	603	17375	1049	701	1999	1461	3.08	7786
2.89	627	18062	1107	741	2068	1510	3.04	8149
3.00	651	18750	1172	789	2143	1566	3.00	8555
3.11	675	19437	1230	830	2212	1616	2.97	8921
3.22	699	20125	1289	871	2281	1665	2.94	9289
3.33	723	20812	1348	913	2349	1714	2.92	9657
3.44	747	21500	1415	962	2426	1771	2.89	10073
3.56	773	22250	1480	1008	2500	1824	2.86	10478
3.67	796	22937	1539	1050	2569	1873	2.84	10850

MERIDIAN, IDAHO

DATE:
TIME: :

DIGESTER PERFORMANCE
ANAEROBIC

BOD: 108
TSS: 153
TEMP 15

PRIMARY DIGESTER VOLUME (GAL): 130000

PLANT FLOW MGD	TOTAL SLUDGE FLOW GPD	VSS LOADING LB/FT3/ DAY	MCRT DAYS	% VSS RED.	ALK. MG/L	GAS PRO. FT3/ DAY	% SOL DIG. SLUDGE
1.56	3501	.05	37.1	64.99	3557	8154	2.13
1.67	3788	.05	34.3	63.18	3469	8338	2.13
1.78	4092	.05	31.8	61.36	3383	8516	2.13
1.89	4386	.06	29.6	59.70	3311	8668	2.13
2.00	4699	.06	27.7	58.04	3240	8818	2.13
2.11	5016	.06	25.9	56.44	3175	8957	2.13
2.23	5347	.06	24.3	54.86	3115	9085	2.13
2.34	5671	.07	22.9	53.40	3060	9204	2.13
2.45	6600	.07	19.7	49.61	2899	9633	2.07
2.56	6990	.08	18.6	48.18	2853	9752	2.07
2.67	7386	.08	17.6	46.80	2810	9864	2.07
2.78	7786	.08	16.7	45.49	2770	9969	2.07
2.89	8148	.09	16.0	44.37	2738	10050	2.07
3.00	8555	.09	15.2	43.17	2703	10143	2.07
3.11	8921	.09	14.6	42.15	2675	10214	2.07
3.22	9288	.10	14.0	41.16	2649	10280	2.07
3.33	9657	.10	13.5	40.23	2625	10342	2.07
3.44	10072	.10	12.9	39.22	2598	10417	2.07
3.56	10477	.10	12.4	38.28	2575	10476	2.07
3.67	10850	.11	12.0	37.46	2554	10527	2.07

APPENDIX E

SINGLE STAGE TRICKLING FILTER PROGRAM OUTPUT

IDEALIZED MATHEMATICAL MODEL OF CENTRALIA, WASHINGTON SINGLE STAGE TRICKLING FILTER WASTEWATER TREATMENT SYSTEM

Prepared by ES Environmental Services,
by contract with Boise State
University, Boise, Idaho. Through a grant from the
Environmental Protection Agency, Region X,
Seattle Washington.

MODEL BASED ON INFORMATION PROVIDED

DATE: FEBRUARY 13
TIME: 01:47

WASTEWATER CHARACTERIZATION

AVERAGE DRY WEATHER FLOW	MGD: 1.48
PEAK DRY WEATHER FLOW	MGD: 3.26
DESIGN FLOW	MGD: 4.3
INFLUENT BOD	MG/L: 148
INFLUENT TSS	MG/L: 158
INFLUENT VSS	(%): 80 *
TEMPERATURE	'C: 15
TKN	MG/L: 30 *
ALKALINITY	MG/L: 100 *
PH	: 6.9
PO4-P	MG/L: 8 *

*
DEFAULT VALUE USED

PLANT CONFIGURATION AND DIMENSIONS

DESIGN AVERAGE DAILY FLOW (MGD): 4.3
DESIGN PEAK WET WEATHER FLOW (MGD): 8.5

PRIMARY CLARIFICATION

NUMBER OF RECTANGULAR CLARIFIERS: 5

DIMENSIONS	EACH	TOTAL
LENGTH (FT):	68	
WIDTH (FT):	15.5	
DEPTH (FT):	6	
WEIR LTH (FT):	15.5	77.5
SFC AREA (FT2):	1054	5270

TRICKLING FILTER

MEDIA TYPE: ROCK
CONSTANT RECIRCULATION
NUMBER OF TRICKLING FILTERS: 2

DIMENSIONS	#1	#2
DIAMETER (FT):	68	85
DEPTH (FT):	6	8
RECIR.RATE(GPM):	1300	2000

IDEALIZED MATHEMATICAL MODEL OF CENTRALIA, WASHINGTON SINGLE STAGE TRICKLING FILTER WASTEWATER TREATMENT SYSTEM

Prepared by ES Environmental Services, by contract with Boise State University, Boise, Idaho. Through a grant from the Environmental Protection Agency, Region X, Seattle Washington.

MODEL BASED ON INFORMATION PROVIDED

DATE: FEBRUARY 13
TIME: 01:47

WASTEWATER CHARACTERIZATION

AVERAGE DRY WEATHER FLOW	MGD:	1.48
PEAK DRY WEATHER FLOW	MGD:	3.26
DESIGN FLOW	MGD:	4.3
INFLUENT BOD	MG/L:	148
INFLUENT TSS	MG/L:	158
INFLUENT VSS	(%):	80 *
TEMPERATURE	'C:	15
TKN	MG/L:	30 *
ALKALINITY	MG/L:	100 *
PH	:	6.9
PO4-P	MG/L:	8 *

*
DEFAULT VALUE USED

PLANT CONFIGURATION AND DIMENSIONS

DESIGN AVERAGE DAILY FLOW (MGD): 4.3
DESIGN PEAK WET WEATHER FLOW (MGD): 8.5

PRIMARY CLARIFICATION

NUMBER OF RECTANGULAR CLARIFIERS: 5

DIMENSIONS	EACH	TOTAL
LENGTH (FT):	68	
WIDTH (FT):	15.5	
DEPTH (FT):	6	
WEIR LTH (FT):	15.5	77.5
SFC AREA (FT2):	1054	5270

TRICKLING FILTER

MEDIA TYPE: ROCK
CONSTANT RECIRCULATION
NUMBER OF TRICKLING FILTERS: 2

DIMENSIONS	#1	#2
DIAMETER (FT):	68	85
DEPTH (FT):	6	8
RECIR.RATE(GPM):	1300	2000

DATE: FEBRUARY 13
TIME: 01:47

SECONDARY CLARIFICATION

NUMBER OF ROUND CLARIFIERS: 2

DIMENSIONS	EACH	TOTAL
DIAMETER (FT):	70	
DEPTH (FT):	8	
WEIR LTH (FT):	220	440
SFC AREA (FT2):	3848	7696

SLUDGE HANDLING

TYPE OF DIGESTION: ANAEROBIC

NUMBER OF PRIMARY DIGESTERS: 1

	#1
VOLUME (GAL):	247000
DIGESTER HEATED	Y
DIGESTER MIXED	Y

NUMBER OF SECONDARY DIGESTERS: 1

VOLUME FOR DIGESTER #1 (GAL): 186500

CENTRALIA, WASHINGTON

DATE: FEBRUARY 13
TIME: 01:47
BOD: 148
TSS: 158
TEMP 15

PRIMARY SYSTEM LOADINGS

FLOW MGD	CLAR. LOADINGS SURFACE GPDSF	WEIR GDP/FT	DETN TIME HRS.
1.11	211	14322	5.11
1.35	256	17419	4.20
1.58	300	20387	3.59
1.82	345	23483	3.12
2.05	389	26451	2.77
2.29	435	29548	2.48
2.52	478	32516	2.25
2.76	524	35612	2.06
3.00	569	38709	1.89
3.23	613	41677	1.76
3.47	658	44774	1.64
3.70	702	47741	1.53
3.94	748	50838	1.44
4.18	793	53935	1.36
4.41	837	56903	1.29
4.65	882	60000	1.22
4.88	926	62967	1.16
5.12	972	66064	1.11
5.35	1015	69032	1.06
5.59	1061	72129	1.02

CENTRALIA, WASHINGTON

DATE: FEBRUARY 13
TIME: 01:47
BOD: 148
TSS: 158
TEMP 15

PRIMARY SYSTEM PERFORMANCE

FLOW MGD	% REMOVAL BOD	TSS	P.C. EFF MG/L BOD	TSS	PRIMARY SLUDGE PROD. LBS TSS	LBS VSS	% SOL	GDP
1.11	55	65	67	55	951	761	7.62	1497
1.35	55	65	67	55	1156	925	7.62	1820
1.58	55	65	67	55	1353	1083	7.62	2131
1.82	55	65	67	55	1559	1247	7.62	2454
2.05	53	65	69	55	1756	1405	7.62	2764
2.29	51	64	73	57	1931	1545	7.62	3040
2.52	49	62	76	60	2052	1641	7.62	3230
2.76	47	60	79	64	2169	1735	7.62	3415
3.00	45	58	82	67	2279	1823	7.62	3588
3.23	43	56	84	70	2378	1902	7.62	3743
3.47	42	54	86	72	2475	1980	7.62	3896
3.70	41	53	88	75	2562	2050	7.62	4034
3.94	39	51	90	77	2648	2119	7.62	4170
4.18	38	50	91	80	2730	2184	7.62	4298
4.41	37	48	93	82	2804	2243	7.62	4415
4.65	36	47	94	84	2878	2302	7.62	4530
4.88	35	46	96	86	2945	2356	7.62	4636
5.12	35	45	97	87	3011	2409	7.62	4741
5.35	34	44	98	89	3072	2458	7.62	4836
5.59	33	43	99	91	3133	2506	7.62	4932

CENTRALIA, WASHINGTON

DATE: FEBRUARY 13
TIME: 01:47
BOD: 148
TSS: 158
TEMP 15

SECONDARY SYSTEM LOADINGS

FLOW MGD	FILTER LOADING GPDSF	FILTER LOADING # BOD 1000FT3	RECIR. RATIO %	CLAR. LOADINGS SURFACE GPDSF	CLAR. LOADINGS WEIR GPD/FT	CLARIFIER DETN. TIME HRS.
1.11	119	6	428	144	2522	9.96
1.35	145	9	351	175	3068	8.19
1.58	169	11	300	205	3590	7.00
1.82	195	14	261	236	4136	6.07
2.05	220	17	231	266	4659	5.39
2.29	246	20	207	298	5204	4.83
2.52	270	23	188	327	5727	4.39
2.76	296	27	172	359	6272	4.01
3.00	322	30	158	390	6818	3.68
3.23	347	33	147	420	7340	3.42
3.47	372	37	136	451	7886	3.19
3.70	397	40	128	481	8409	2.99
3.94	423	43	120	512	8954	2.81
4.18	449	47	113	543	9500	2.64
4.41	473	50	107	573	10022	2.51
4.65	499	54	102	604	10568	2.38
4.88	524	57	97	634	11090	2.27
5.12	550	61	92	665	11636	2.16
5.35	574	65	88	695	12159	2.07
5.59	600	68	85	726	12704	1.98

CENTRALIA, WASHINGTON

DATE: FEBRUARY 13
TIME: 01:47
BOD: 148
TSS: 158
TEMP 15

SECONDARY SYSTEM PERFORMANCE

FLOW	EFF CONC. MG/L		SEC. SLUDGE PROD		TOTAL SLUDGE PROD			
MGD	BOD	SS	LBS TSS	LBS VSS	LBS TSS	LBS VSS	% SOL	GPD
1.11	4	4	237	174	1384	1092	5.15	3226
1.35	6	5	324	235	1658	1302	4.92	4043
1.58	7	7	414	297	1912	1496	4.74	4842
1.82	9	8	514	365	2170	1690	4.57	5687
2.05	10	10	613	432	2409	1868	4.44	6503
2.29	11	11	720	503	2651	2048	4.32	7358
2.52	13	13	826	572	2877	2213	4.22	8181
2.76	14	14	938	645	3107	2380	4.12	9039
3.00	16	16	1052	718	3331	2541	4.04	9897
3.23	17	17	1163	788	3541	2690	3.96	10718
3.47	18	18	1281	861	3755	2841	3.89	11573
3.70	20	20	1394	931	3956	2981	3.83	12390
3.94	21	21	1513	1004	4161	3123	3.77	13240
4.18	22	23	1633	1077	4363	3261	3.71	14086
4.41	23	24	1748	1147	4552	3390	3.66	14894
4.65	24	25	1869	1219	4746	3521	3.62	15734
4.88	26	27	1985	1288	4930	3643	3.57	16536
5.12	27	28	2107	1359	5118	3768	3.53	17369
5.35	28	29	2223	1428	5295	3885	3.50	18165
5.59	29	31	2345	1498	5478	4004	3.46	18991

CENTRALIA, WASHINGTON

DATE: FEBRUARY 13
TIME: 01:47

DIGESTER PERFORMANCE
ANAEROBIC

BOD: 148
TSS: 158
TEMP 15

PRIMARY DIGESTER VOLUME (GAL): 247000

PLANT FLOW MGD	TOTAL SLUDGE FLOW GPD	VSS LOADING LB/FT3/ DAY	MCRT DAYS	% VSS RED.	ALK. MG/L	GAS PRD. FT3/ DAY	% SOL DIG. SLUDGE
1.11	3225	.03	76.6	75.00	4631	12283	2.16
1.35	4043	.04	61.1	75.00	4425	14652	2.08
1.58	4842	.05	51.0	71.83	4262	16120	2.13
1.82	5686	.05	43.4	68.47	4117	17356	2.18
2.05	6502	.06	38.0	65.50	3997	18359	2.23
2.29	7358	.06	33.6	62.66	3888	19247	2.27
2.52	8180	.07	30.2	60.15	3795	19970	2.31
2.76	9039	.07	27.3	57.74	3709	20611	2.34
3.00	9897	.08	25.0	55.51	3632	21156	2.36
3.23	10718	.08	23.0	53.53	3565	21601	2.38
3.47	11573	.09	21.3	51.62	3501	21996	2.40
3.70	12389	.09	19.9	49.91	3445	22320	2.42
3.94	13239	.09	18.7	48.26	3391	22607	2.43
4.18	14086	.10	17.5	46.71	3342	22851	2.44
4.41	14894	.10	16.6	45.33	3298	23049	2.45
4.65	15734	.11	15.7	43.97	3255	23224	2.46
4.88	16536	.11	14.9	42.75	3216	23365	2.47
5.12	17369	.11	14.2	41.55	3179	23488	2.47
5.35	18164	.12	13.6	40.47	3145	23586	2.48
5.59	18990	.12	13.0	39.40	3112	23669	2.48

APPENDIX F

TWO STAGE TRICKLING FILTER PROGRAM OUTPUT

IDEALIZED MATHEMATICAL MODEL OF CALDWELL, IDAHO TWO STAGE TRICKLING FILTER WASTEWATER TREATMENT SYSTEM

Prepared by ES Environmental Services,
by contract with Boise State
University, Boise, Idaho. Through a grant from the
Environmental Protection Agency, Region X,
Seattle Washington.

CALIBRATED MODEL

DATE:
TIME: :

WASTEWATER CHARACTERIZATION

AVERAGE DRY WEATHER FLOW	MGD: 3.8
PEAK DRY WEATHER FLOW	MGD: 5
DESIGN FLOW	MGD: 7.78
INFLUENT BOD	MG/L: 325
INFLUENT TSS	MG/L: 396
INFLUENT VSS	(%): 80 *
TEMPERATURE	°C: 15
TKN	MG/L: 30 *
ALKALINITY	MG/L: 100 *
PH	: 7.4
PO4-P	MG/L: 8 *

*
DEFAULT VALUE USED

PLANT CONFIGURATION AND DIMENSIONS

DESIGN AVERAGE DAILY FLOW (MGD): 7.78
DESIGN WET PEAK WEATHER FLOW (MGD): 15

PRIMARY CLARIFICATION

NUMBER OF ROUND CLARIFIERS: 1

DIMENSIONS	EACH	TOTAL
DIAMETER (FT):	110	
DEPTH (FT):	8.75	
WEIR LTH (FT):	345	345
SFC AREA (FT2):	9503	9503

DATE:
TIME: :

TRICKLING FILTERS

PRIMARY FILTER

MEDIA TYPE: ROCK
NUMBER OF TRICKLING FILTERS: 1

DIMENSIONS	EACH
DIAMETER (FT):	140
DEPTH (FT):	6.33
RECIR.RATE(GPM):	10400

SECONDARY FILTER

MEDIA TYPE: STACKED PLASTIC
NUMBER OF TRICKLING FILTERS: 1

DIMENSIONS	EACH
DIAMETER (FT):	50
DEPTH (FT):	19
RECIR.RATE(GPM):	8400

SECONDARY CLARIFICATION

NUMBER OF ROUND CLARIFIERS: 2

DIMENSIONS	EACH	TOTAL
DIAMETER (FT):	110	
DEPTH (FT):	8	
WEIR LTH (FT):	345	690
SFC AREA (FT2):	9503	19006

SLUDGE HANDLING

SLUDGE THICKENING : YES
TYPE : GRAVITY

TYPE OF DIGESTION: ANAEROBIC
NUMBER OF PRIMARY DIGESTERS: 1

	#1
VOLUME (GAL):	151000
DIGESTER HEATED	Y
DIGESTER MIXED	Y

NUMBER OF SECONDARY DIGESTERS: 1

VOLUME FOR DIGESTER #1 (GAL): 144000

CALDWELL, IDAHO
MATHEMATICAL MODEL
SINGLE STAGE TRICKLING FILTER

DATE:
TIME: :
BOD: 325
TSS: 396
TEMP 15

PRIMARY SYSTEM LOADINGS

FLOW MGD	CLAR. LOADINGS SURFACE GPDSF	WEIR GDP/FT	DETN TIME HRS.
2.85	300	8260	5.24
3.23	340	9362	4.62
3.61	380	10463	4.14
4.00	421	11594	3.73
4.38	461	12695	3.41
4.76	501	13797	3.14
5.14	541	14898	2.90
5.53	582	16028	2.70
5.91	622	17130	2.53
6.29	662	18231	2.37
6.67	702	19333	2.24
7.06	743	20463	2.11
7.44	783	21565	2.01
7.82	823	22666	1.91
8.20	863	23768	1.82
8.58	903	24869	1.74
8.97	944	26000	1.66
9.35	984	27101	1.60
9.73	1024	28202	1.53
10.1	1064	29304	1.48

CALDWELL, IDAHO

DATE:
TIME: :
BOD: 325
TSS: 396
TEMP 15

PRIMARY SYSTEM PERFORMANCE

FLOW MGD	% REMOVAL BOD	TSS	P.C. EFF MG/L BOD	TSS	PRIMARY SLUDGE PROD. LBS TSS	LBS VSS	% SOL	GDP
2.85	55	65	146	139	6118	4895	7.62	9632
3.23	55	65	146	139	6934	5547	7.62	10916
3.61	54	65	151	139	7750	6200	7.62	12201
4.00	51	65	158	140	8549	6839	7.62	13459
4.38	49	63	164	148	9061	7249	7.62	14265
4.76	48	61	170	156	9542	7633	7.62	15022
5.14	46	59	176	163	9994	7995	7.62	15735
5.53	44	57	181	170	10432	8346	7.62	16424
5.91	43	56	185	176	10835	8668	7.62	17058
6.29	42	54	189	182	11216	8973	7.62	17659
6.67	41	53	193	188	11578	9262	7.62	18228
7.06	40	51	197	193	11931	9544	7.62	18783
7.44	38	50	200	198	12257	9806	7.62	19297
7.82	38	49	203	203	12568	10055	7.62	19787
8.20	37	48	206	208	12865	10292	7.62	20255
8.58	36	46	208	212	13149	10519	7.62	20702
8.97	35	45	211	217	13428	10742	7.62	21140
9.35	34	44	213	220	13688	10950	7.62	21550
9.73	34	43	216	224	13937	11150	7.62	21942
10.1	33	42	218	228	14177	11341	7.62	22319

CALDWELL, IDAHO

DATE:
TIME: :
DOD: 325
TSS: 396
TEMP 15

SECONDARY SYSTEM LOADINGS

FLOW	#1 FILTER LOADING		RECIR.	#2 FILTER LOADING		RECIR.	CLAR. LOADINGS		CLARIFIER
MGD	GPDSF	# BOD 1000FT3	RATIO %	GPDSF	# BOD 1000FT3	RATIO %	SURFACE GPDSF	WEIR GPD/FT	DETN. TIME HRS.
2.85	185	32	525	1451	14	424	150	4130	9.58
3.23	209	39	463	1645	19	374	170	4681	8.45
3.61	234	46	414	1838	24	335	190	5231	7.56
4.00	259	54	374	2037	30	302	210	5797	6.82
4.38	284	61	341	2230	37	276	230	6347	6.23
4.76	309	69	314	2424	44	254	250	6898	5.73
5.14	333	77	291	2617	51	235	270	7449	5.31
5.53	359	85	270	2816	60	218	291	8014	4.94
5.91	383	93	253	3009	68	204	311	8565	4.62
6.29	408	101	238	3203	77	192	331	9115	4.34
6.67	433	110	224	3397	86	181	351	9666	4.09
7.06	458	118	212	3595	96	171	371	10231	3.87
7.44	483	127	201	3789	106	162	391	10782	3.67
7.82	507	135	191	3982	116	154	411	11333	3.49
8.20	532	144	182	4176	127	147	431	11884	3.33
8.58	557	153	174	4369	138	140	451	12434	3.18
8.97	582	161	166	4568	149	134	472	13000	3.04
9.35	607	170	160	4761	161	129	492	13550	2.92
9.73	632	179	153	4955	173	124	512	14101	2.81
10.1	656	188	148	5148	185	119	532	14652	2.70

CALDWELL, IDAHO

DATE:
TIME: :
BOD: 325
TSS: 396
TEMP 15

SECONDARY SYSTEM PERFORMANCE

FLOW	EFF CONC. MG/L		SEC. SLUDGE PROD		TOTAL SLUDGE PROD			
MGD	BOD	SS	LBS TSS	LBS VSS	LBS TSS	LBS VSS	% SOL	GPD
2.85	14	14	1630	1102	8403	6520	4.93	20435
3.23	17	17	1968	1315	9369	7236	4.79	23452
3.61	20	20	2319	1531	10306	7921	4.67	26475
4.00	22	23	2688	1756	11237	8595	4.56	29577
4.38	25	26	3057	1976	12118	9225	4.46	32593
4.76	27	29	3432	2197	12974	9830	4.37	35599
5.14	30	32	3813	2417	13807	10412	4.29	38593
5.53	33	35	4208	2642	14640	10987	4.21	41651
5.91	35	38	4597	2860	15431	11528	4.15	44615
6.29	37	41	4988	3077	16204	12050	4.09	47562
6.67	40	44	5382	3292	16960	12554	4.03	50493
7.06	42	47	5788	3511	17718	13055	3.97	53482
7.44	44	50	6185	3722	18442	13528	3.92	56377
7.82	46	53	6583	3932	19152	13986	3.88	59255
8.20	48	55	6982	4139	19848	14432	3.83	62116
8.58	50	58	7382	4345	20531	14864	3.79	64959
8.97	52	61	7793	4554	21221	15296	3.75	67860
9.35	54	64	8193	4755	21881	15705	3.71	70671
9.73	56	66	8594	4954	22531	16104	3.68	73465
10.1	58	69	8995	5152	23171	16493	3.64	76243

CALDWELL, IDAHO

DATE:
TIME: :

DIGESTER PERFORMANCE
ANAEROBIC

BOD: 325
TSS: 396
TEMP 15

PRIMARY DIGESTER VOLUME (GAL): 151000

PLANT FLOW MGD	TOTAL SLUDGE FLOW GPD	VSS LOADING LB/FT3/ DAY	MCRT DAYS	% VSS RED.	ALK. MG/L	GAS PRO. FT3/ DAY	% SOL DIG. SLUDGE
2.85	20434	.32	7.40	26.97	4437	26386	3.93
3.23	23451	.36	6.40	24.35	4311	26433	3.92
3.61	26474	.39	5.70	22.19	4200	26365	3.90
4.00	29576	.43	5.10	20.33	4100	26218	3.87
4.38	32592	.46	4.60	18.80	4012	26024	3.84
4.76	35599	.49	4.20	17.49	3932	25799	3.81
5.14	38593	.52	3.90	16.36	3860	25554	3.78
5.53	41651	.54	3.60	15.34	3793	25290	3.74
5.91	44615	.57	3.40	14.47	3732	25026	3.71
6.29	47562	.60	3.20	13.69	3676	24760	3.68
6.67	50492	.62	3.00	13.00	3624	24494	3.65
7.06	53482	.65	2.80	12.37	3575	24224	3.62
7.44	56377	.67	2.70	11.81	3530	23965	3.59
7.82	59255	.69	2.50	11.30	3487	23710	3.56
8.20	62115	.71	2.40	10.83	3448	23460	3.54
8.58	64959	.74	2.30	10.41	3410	23215	3.51
8.97	67860	.76	2.20	10.01	3374	22971	3.48
9.35	70670	.78	2.10	9.652	3341	22738	3.46
9.73	73464	.80	2.10	9.319	3309	22512	3.44
10.1	76243	.82	2.00	9.010	3279	22291	3.41

APPENDIX G

ROTATING BIOLOGICAL CONTACTORS PROGRAM OUTPUT

IDEALIZED MATHEMATICAL MODEL OF MONROE, WASHINGTON ROTATING BIOLOGICAL CONTACTORS WASTEWATER TREATMENT SYSTEM

DATE: FEBRUARY 13, 1981

Prepared by ES Environmental Services,
by contract with Boise State
University, Boise, Idaho. Through a grant from the
Environmental Protection Agency, Region X,
Seattle Washington.

DATE: FEBRUARY 13
TIME: 02:08

WASTEWATER CHARACTERIZATION

AVERAGE DRY WEATHER FLOW	MGD: .5
PEAK DRY WEATHER FLOW	MGD: .6
DESIGN FLOW	MGD: 1.4
INFLUENT BOD	MG/L: 206
INFLUENT TSS	MG/L: 186
INFLUENT VSS	(%): 80 *
TEMPERATURE	°C: 15
TKN	MG/L: 30 *
ALKALINITY	MG/L: 100 *
PH	: 7
PO4-P	MG/L: 8 *

*
DEFAULT VALUE USED

PLANT CONFIGURATION AND DIMENSIONS

DESIGN AVERAGE DAILY FLOW (MGD) : 1.4
DESIGN PEAK WET WEATHER FLOW (MGD): 2.8

PRIMARY CLARIFICATION
SCREENING

TYPE	: BAUER SIDE HILL
NUMBER OF SCREENS	: 3
WIDTH (FT)	: 5
HEIGHT (FT)	: 5
SCREEN OPENING(IN)	: .06
CAPACITY EACH(MGD)	: 2.1
TOTAL CAPACITY MGD	: 6.3

RBC

MANUFACTURER	: AUTOTROL
TYPE	: MECHANICAL DRIVE
NUMBER OF PROCESS TRAINS	: 2
NUMBER OF SHAFTS PER TRAIN	: 2
SHAFT #1 SURFACE AREA (FT2)	: 96000
SHAFT #2 SURFACE AREA (FT2)	: 96000

DATE: FEBRUARY 13
TIME: 02:08

SECONDARY CLARIFICATION

NUMBER OF RECTANGULAR CLARIFIERS: 2

DIMENSIONS	EACH	TOTAL
LENGTH (FT):	76.3	
WIDTH (FT):	16.7	
DEPTH (FT):	10	
WEIR LTH (FT):	130	130
SFC AREA (FT2):	2548	2548

SLUDGE HANDLING

TYPE OF DIGESTION: AEROBIC

NUMBER OF DIGESTERS : 2

VOLUME OF #1 GAL: 47100
VOLUME OF #2 GAL: 104700

MONROE, WASHINGTON

DATE: FEBRUARY 13
TIME: 02:08
BOD: 206
TSS: 186
TEMP 15

PRIMARY SYSTEM PERFORMANCE

FLOW MGD	% REMOVAL BOD	% REMOVAL TSS	P.C. EFF MG/L BOD	P.C. EFF MG/L TSS	PRIMARY SLUDGE PROD. LBS TSS	LBS VSS	% SOL	GDP
.380	10	15	185	158	87	70	7.62	137
.450	10	15	185	158	105	84	7.62	165
.530	10	15	185	158	123	99	7.62	194
.600	10	15	185	158	140	112	7.62	220
.680	10	15	185	158	158	127	7.62	249
.760	10	15	185	158	177	141	7.62	278
.830	10	15	185	158	193	155	7.62	304
.910	10	15	185	158	212	169	7.62	333
.980	10	15	185	158	228	182	7.62	359
1.06	10	15	185	158	247	197	7.62	388
1.14	10	15	185	158	265	212	7.62	418
1.21	10	15	185	158	282	225	7.62	443
1.29	10	15	185	158	300	240	7.62	473
1.36	10	15	185	158	316	253	7.62	498
1.44	10	15	185	158	335	268	7.62	528
1.52	10	15	185	158	354	283	7.62	557
1.59	10	15	185	158	370	296	7.62	582
1.67	10	15	185	158	389	311	7.62	612
1.74	10	15	185	158	405	324	7.62	637
1.82	10	15	185	158	423	339	7.62	667

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SECONDARY SYSTEM LOADINGS

FLOW MGD	SHAFT LOADING BOD/1000 FT2 SHAFT 1	SHAFT LOADING BOD/1000 FT2 TOTAL	HYD LOAD GPDSF	CLAR. LOADINGS SURFACE GPDSF	CLAR. LOADINGS WEIR GPD/FT	CLAR. LOADINGS SOLIDS #/SF/DAY	CLARIFIER DETN. TIME HRS.
.380	3.02	1.51	.98	147	1442	.23	12.2
.450	3.62	1.81	1.17	177	1730	.27	10.1
.530	4.27	2.13	1.38	208	2038	.32	8.63
.600	4.83	2.42	1.56	235	2307	.36	7.62
.680	5.48	2.74	1.77	267	2615	.41	6.73
.760	6.12	3.06	1.98	298	2923	.46	6.02
.830	6.68	3.34	2.16	326	3192	.50	5.51
.910	7.33	3.66	2.37	357	3500	.55	5.03
.980	7.89	3.95	2.55	385	3769	.59	4.67
1.06	8.54	4.27	2.76	416	4076	.64	4.32
1.14	9.18	4.59	2.97	447	4384	.69	4.01
1.21	9.74	4.87	3.15	475	4653	.73	3.78
1.29	10.3	5.19	3.36	506	4961	.78	3.55
1.36	10.9	5.48	3.54	534	5230	.83	3.36
1.44	11.6	5.80	3.75	565	5538	.87	3.18
1.52	12.2	6.12	3.96	596	5846	.92	3.01
1.59	12.8	6.40	4.14	624	6115	.96	2.88
1.67	13.4	6.72	4.35	655	6423	1.01	2.74
1.74	14.0	7.01	4.53	683	6692	1.06	2.63
1.82	14.6	7.33	4.74	714	7000	1.10	2.51

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SECONDARY SYSTEM PERFORMANCE

FLOW MGD	EFF CONC. MG/L BOD	SS	SEC. SLUDGE PROD LBS TSS	LBS VSS	TOTAL SLUDGE PROD LBS TSS	LBS VSS	% SOL	GPD
.380	52	55	283	185	371	254	2.42	1837
.450	56	58	336	217	441	301	2.43	2178
.530	58	62	391	251	514	350	2.43	2536
.600	61	65	438	280	577	391	2.43	2845
.680	63	67	491	312	649	438	2.44	3193
.760	65	70	544	343	720	485	2.44	3538
.830	66	72	589	370	782	525	2.45	3835
.910	68	74	640	400	852	570	2.45	4172
.980	69	76	685	426	913	609	2.45	4465
1.06	71	78	735	456	982	653	2.45	4795
1.14	72	79	785	484	1050	696	2.46	5123
1.21	73	81	828	509	1110	734	2.46	5408
1.29	74	82	877	537	1177	777	2.46	5731
1.36	75	84	920	561	1236	814	2.47	6011
1.44	76	85	968	588	1303	856	2.47	6329
1.52	77	86	1016	615	1369	898	2.47	6646
1.59	78	87	1057	638	1427	934	2.47	6920
1.67	78	89	1104	664	1493	975	2.48	7233
1.74	79	90	1145	687	1550	1010	2.48	7504
1.82	80	91	1192	712	1615	1051	2.48	7813

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DIGESTER PERFORMANCE
AEROBIC

DIGESTER VOLUME (GAL): 151800

PLANT FLOW MGD	TOTAL SLUDGE FLOW GPD	VSS LOADING LB/FT3/ DAY	MCRT DAYS	% VSS RED.	ALK. MG/L	GAS PRO. FT3/ DAY	% SOL DIG. SLUDGE
.38	1836	.01	82.6	74.03	NA	NA	1.20
.45	2178	.01	69.7	70.63	NA	NA	1.27
.53	2536	.02	59.9	67.37	NA	NA	1.33
.60	2844	.02	53.4	64.80	NA	NA	1.38
.68	3193	.02	47.5	62.12	NA	NA	1.43
.76	3537	.02	42.9	59.68	NA	NA	1.47
.83	3835	.03	39.6	57.72	NA	NA	1.51
.91	4172	.03	36.4	55.66	NA	NA	1.55
.98	4464	.03	34.0	53.98	NA	NA	1.58
1.06	4795	.03	31.7	52.20	NA	NA	1.61
1.14	5123	.03	29.6	50.55	NA	NA	1.64
1.21	5407	.04	28.1	49.20	NA	NA	1.67
1.29	5730	.04	26.5	47.75	NA	NA	1.70
1.36	6011	.04	25.3	46.56	NA	NA	1.72
1.44	6329	.04	24.0	45.28	NA	NA	1.74
1.52	6645	.04	22.8	44.07	NA	NA	1.76
1.59	6920	.05	21.9	43.08	NA	NA	1.78
1.67	7232	.05	21.0	42.00	NA	NA	1.80
1.74	7504	.05	20.2	41.10	NA	NA	1.82
1.82	7812	.05	19.4	40.13	NA	NA	1.84

NA- NOT APPLICABLE FOR AEROBIC DIGESTION